ISSN 1173-5996

Statistical Analysis of Hospitality Industry Fire Experience

by
Tzu-Yin Chen

Supervised by

Mike Spearpoint

Fire Engineering Research Report 01/3
March 2001

This report was presented as a project report as part of the
M.E. (Fire) degree at the University of Canterbury

School of Engineering
University of Canterbury
Private Bag 4800
Christchurch, New Zealand

Phone 643 364-2250
Fax 643 364-2758
www.civil.canterbury.ac.nz

ABSTRACT

By their very nature as transient properties, the hospitality industry brings a large number of people together in unfamiliar surroundings. In this report, data collected by the New Zealand Fire Service were used to identify the trends for hospitality industry fire experience.

Overall, the hospitality industry stands not only for a high percentage of national economic development but also builds the reputation of New Zealand. A severe fire incident may cause job losses for an indefinite period of time, tradesmen and suppliers may lose a large and regular source of income, the town may lose one of its greatest assets and New Zealand's reputation might be damaged and tourism discouraged.

Generally the number of fire incidents in the New Zealand hospitality industry has decreased since 1997. It was found that over the 15 years analysed, careless action was the most common cause, followed by suspicious, but these were not the most hazardous. The most hazardous fires were shown to be bedroom fires originating in soft furnishings. Almost all the fatal fire incidents could be associated with accommodation type properties, and most of them occurred at night-time when occupants were still asleep. Since the highest percentage of fire incidents occurred in wintertime, it was suspected that more frequent usage of heating appliances was the main cause.

As opposed to fatal incidents, most incidents that lead to an injury originated in kitchens where the injured occupants were attempting to control the fire. Heat sources were mainly from cooking appliances with cooking material being ignited, and incidents mainly occurred at night-time but not during sleeping hours. Restaurant/Cafe/Diner as a subcategory of the hospitality industry stands out with the highest incidents with injury or incidents as a total.

It is therefore essential to improve the current fire protection system of the hospitality industry. Fire detection and suppression systems are urged to be installed, as well as suitable law enforcement. Regular inspection and maintenance are also required together with public education, staff training, good housekeeping, and increased security. These would go far toward reducing the number of hospitality fire incidents and, consequently, the life hazards they involve.

ACKNOWLEDGEMENTS

Throughout the course of this project I have received assistance and support from a large number of people who I would like to acknowledge, including:

- My supervisor, Mr. Michael Spearpoint, who guided me through the process and gave me a lot encouragement.
- Mr. Mark Chubb of New Zealand Fire Service, who came up with the need to do this report and provided suggestions along the way.
- Mr. Roger Chang of New Zealand Fire Service, thank you for preparing the original Fire Incident Database for this report, and your willingness to help always.
- Mr. Alistair Henderson of New Fire Service, who provided the explanations for some of the trends.
- The New Zealand Fire Service Commission Board, who provided financial support for the MEFE program.
- The staff of the Engineering and Physical Sciences libraries, especially Mrs Christine McKee, for assistance in finding papers.
- The other MEFE students who have suffered and laughed with me along the way.
- My family, especially Mum and Dad, I would not have made it through this report had it not been for your help and understanding; love you always.
- Lastly but not least my supportive friends: Caroline, Shin-I, Linda, Yi-Pei, Cecilia, Wendy, Henry and many more.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

List of Tables

List of Figures

1 INTRODUCTION

1.1 Research Motive

Recent fire research by the New Zealand Fire Service [1] has indicated that the lodging and entertainment industries sector/hospitality industry experienced four times more fires per establishment than the national average and accounted for nearly all recent fire deaths in commercial establishments. It is shown in Table 1 that the hospitality industry has on average 16.6 incidents per 1,000 establishments, which is the 3rd highest risky industry following "Secondary Industry" and "Utilities".

Table 1 Commercial fire incidents according to Fire Service Data

Fire Incidents/1,000 Establishments		
C	Secondary Industry	109.10
D	Utilities	62.04
H	Hospitality	16.63
N	Education	14.27
P	Recreation	11.12
O	Medical	9.314
J	Communications	6.39
I	Transport	6.03
G	Retail Trade	5.23
B	Mining	4.66
Q	Miscellaneous	4.05
M	Government	2.15
L	Business Support	1.55
F	Wholesale Trade	1.44
E	Building Construction	1.29
K	Finance	0.78
A	Agriculture	0.56
	National Mean	4.08

The fire safety record in this sector develops a significant national concern for two reasons: first, a single fire may result in many deaths and causalities and secondly, a record of fire safety deficiencies can discourage tourism and affect the national economic state. Therefore it is essential to understand the factors causing or contributing to increase incidence of fires and fire deaths in the hospitality industry, so that recommendations can be made to improve the situation.

1.2 Definition of Hospitality

Depending on the classification standard adapted and assumptions made, different organisations can have a different definition for hospitality. Generally speaking, the hospitality industry is known as an industry providing places to stay and food to eat. However, different classifications might have minor disagreements on the detailed parts of the definition. For the purpose of this report, hospitality industry was classified with New Zealand Fire Service Fire Incident's Category [2], which was based on the Australian and New Zealand Standard Industrial Classification (ANZSIC) Division H – Accommodation, Cafes and Restaurants [3].

ANZSIC is an approved classification code widely accepted by Australia and New Zealand. Within the classification, Division H specifically divides the hospitality industry into more detailed sections. The industry includes Accommodation, Cafes and Restaurants etc. ANZSIC coded industries are numbered and the hospitality parts of the classification are listed below:

H571000 Accommodation
H572000 Pubs, Taverns and Bars
H573000 Cafes and Restaurants
H574000 Clubs (Hospitality)

According to the above ANZSIC classification, the New Zealand Fire Service has classified all the fire incident data into those categories but dropped the last two non-important "00". They were used and treated as "hospitality" throughout this report.

The New Zealand Fire Service divides all properties into 9 major categories according to its general or specific property use, including:

- Assembly
- Educational
- Institutional
- Residential
- Commercial
- Primary Industry/Utility
- Manufacturing
- Storage
- Miscellaneous

Within the above major categories, "hospitality industry" is subdivided into residential and commercial categories:

Table 2 FIRS Property Type Classification

Property Type Description	Specific Property Use FIRS 1995 (mid)-1999	Specific Property Use FIRS 1991-1995 (mid)	ANZSIC Code(s)
RESIDENTIAL			
Boarding/Dormitories	**43**		
Boarding houses	4301 4310/4320		5710
Halfway houses	4302	4699	8722
University/school dormitories	4303	4610	5710
Nurses' homes	4304	4630	5710
Military/police barracks	4305	4640	5710
Bunk house/workers' barracks	4306	4660	5710
Hotels/Motels/Lodges	**44**		
With liquor license	4401	4510	5720
Without liquor license	4402	4410	5710
COMMERCIAL			
Food & Beverage Sales	**51**		
Supermarket (>1000 m^2)	5101	5110	5110
Supermarket (<1000 m^2)	5102	5120	5110
Dairy, butcher, bakery, other	5103	5130	5110/5121/5124/5129
Restaurant, café, diner	5104	1610	5730
Sportsclubs w/restaurants	5105	1620	5740
Takeaway bars	5106	1640	5125
Pub/tavern/inn	5107	1630	5720
Nightclub	5108	1620	5720
Liquor store	5110	5140	5123
MISCELLANEOUS			
Outdoor Areas	**93**		
Campsites & RV parks	9306	9350	9239

Note: All the categories of the hospitality industry were defined and classified following ANZSIC code, except for Campsites & RV parks. Although within the ANZSIC code, these were classified as 9239, which was not in Division H. However, it was still a major short-term accommodation facility, therefore it was taken as the only exception and included in the hospitality industry. All categories considered as part of the hospitality industry are shaded (Table 2).

Based on the ANZSIC classification, Cafes and Restaurants accounted for approximately 35 percent of the total hospitality industry in New Zealand, and Accommodation accounts for another 30 percent. The remaining proportion was divided between the other units. This industry included all units mainly engaged in providing hospitality services in the form of accommodation, meals and drinks. Clubs, bars and taverns are also included. The main customers in this industry are likely to be international, domestic and business travellers. Therefore a good fire safety record is vital to the country's economy.

2 INTERNATIONAL EXPERIENCE

The building practice (culture) and social-economic conditions of individual countries have a significant impact on the fire risk of these countries and make the national fire risk of each country unique.

2.1 Hotel/Motel Fire Experiences

First, there is no agreed definition of what constitutes " hospitality industry". Further, most background literature reviewed by the author in the given time frame concentrated on Hotel/Motel fire experience and covered a long period of time rather than the whole hospitality industry. A complete and logical international comparison might be hard to reach, but this study could still be used as an indication and model to follow. Some recommendations could also be drawn from this study.

2.1.1 USA Hotel Fire Experience

In recent years, due to the establishment of the Hotel and Motel Fire Safety Act of 1990 [4], the installation of sprinklers has become a general requirement throughout all portions of hotel buildings, regardless of their height. Thus, the possibility of a large fire and the production of smoke have been reduced.

The statistics and subsequent conclusions vary from year to year, but generally most fires in hotels start in the guestrooms, with cause from careless acts or arson. Cooking fires, appliances and careless smoking are also the major cause of fire incidents. Major causes of injury are also listed below [5]:

Table 3 Leading Causes of US Hotel/Motel Injuries

Rank	1985	1994
1	Arson	Careless Smoking
2	Careless Smoking	Arson
3	Cooking	Cooking

Some background research for the Hotel and Motel Fire Safety Act of 1990 finds that, when a property is well constructed and maintained, automatic sprinklers and smoke detectors provide the most effective safeguards against the loss of life and property from fire. Therefore the guidelines for places of public accommodation [6] state the following:

1. A requirement that hard-wired, single station smoke detectors be installed in accordance with National Fire Protection Association Standard 74 in each guest room in each place of public accommodation affecting commerce; and
2. A requirement that an automatic sprinkler system be installed in accordance with National Fire Protection Association Standard 13 or 13-R, whichever is appropriate, in each place of public accommodation affecting commerce except those places that are 3 stories or lower.
3. Places of public accommodation affecting commerce means any inn, hotel or other establishment not owned by the Federal Government that provides lodging to transient guests, except that such term does not include an establishment treated as an apartment building for purposes of any local law or regulation or an establishment located within a building that contains not more than 5 rooms for rent or hire and that is actually occupied as a residence by the proprietor of such establishment.

Overall, the US has done a good job on fire safety. Although there are always improvements to be done, it could be a raw model for New Zealand to follow.

2.1.2 UK/EU Hotel Fire Experience [7], [8], [9]

Britain

Britain has taken a strong line in hotel fire safety since 1972, and decides to enforce it in several stages. The UK fire statistics show that:

- A greater chance of someone deliberately setting fire to premises than one would expect;
- Although the statistics change throughout the years, generally the top three causes are arson, careless handling of hot substances and appliance defaults.

Europe

According to Reference [9] a study done by APAVE (French private company) stated that before the "1986 Recommendation Fire Safety Standards for Hotels (EEC/666/86)", there were no reasonably complete hotel fire safety regulations in many community states. The EU standards were, in many cases, written into national legislation verbatim. In the majority of instances it was considered that the minimum criteria had been met and actually exceeded.

Generally the top causes of fire for each country are different due to its own sociality culture. For example, the highest cause of hotel fire incidents in France is carelessness and disposal of smokers' materials due to the fact that there is a greater number of smokers.

According to Reference [10], the EU Package Travel Regulations, which became Law on 1 Jan 1993 also suggests the following measures to improve Hotel/Motel fire safety:

- A direct responsibility be imposed on tour operators for the safety of their customers.
- The prohibition of inaccurate brochure descriptions with penalties for non-compliance.

2.2 Restaurant Fire Experience [11]

Due to the limited background sources on this topic, conclusions drawn for this part of the report could only be an indication, which may not reflect the international current situation.

Most restaurant fire incidents occurred due to the following reasons:

- Combustible construction
- Poor protection and alarm system
- Equipment fault
- Bad housekeeping.

It is suggested to have a proper structural design to avoid the spread of fire especially around the kitchen areas. Cooking appliances should be properly installed, maintained, and regularly cleaned. Adequate protection must be provided against fires originating in restaurant type cooking equipment. Along with all the above, it is also important to have properly-trained staff in the case of emergency.

3 METHODOLOGY

3.1 Assumptions

Assumptions have been made throughout this report and they are explained in each related section.

3.2 Fire Incident Data

3.2.1 The New Zealand Fire Service Fire Incident Reporting System (FIRS)

The primary objective of FIRS is to provide information:

- To facilitate strategic planning and feedback for operations through the study of trends and measurement of the effectiveness of fire safety practices;
- For statistical purposes.

Generally all fire incidents have been classified into different categories according to the property's specific property use. Also all information about each incident has been coded with numbers or symbols to simplify the FIRS system so that accurate information will be obtained from the field.

3.2.2 Data Source/Range

Since recent fire research and a previous section of this report have shown that the hospitality industry had an unusually high risk of fire, this report will emphasise recent fire incident data, instead of really long term ones. The prime source of data used were the New Zealand Fire Service Fire Incident Reporting System data from 1986 to September 2000, according to the general and specific property use, provided by the New Zealand Fire Service [12].

Other sources of data and information were also adapted; they are for the purpose of comparison with international experience rather than detailed data analysis. These were obtained from a number of published sources. Details of these sources have been provided in the Reference and the Bibliography at the end of this report.

3.2.3 Data Sorting

The prime hospitality fire incident data provided by the New Zealand Fire Service were defined according to both general and specific property uses.

General Property Use (GPUse) – designation identifies the overall use of the property. Where a property has two or more completely different general uses, and there is no classification to describe the combination, then the predominant use at the point of origin of the incident is to be used.

Specific Property Use (SPUse) – designation identifies the specific use of the property whin a particular complex/the actual use of the property where the incident occurred.

Eg. A fish and chip shop in a high rise office block

GPUse:	office block	44
SPUse:	fish and chip shop	5106

Using the definition for hospitality described in the previous section 1.2 to concentrate on SPUse, and cut out some of the minor/unrelated ones even though they were classified as hospitality due to the GPUse. eg single house on hotel property, defined hospitality covers about 65% of the original given database. For a detailed table please refer to Appendix A.

3.2.4 Data Structure

Data from the database were extracted and imported into Microsoft Access where base tables were developed. The data maintains the set standard coding as described in the Fire Incident Reporting System Instruction and Coding Manual.

All fire incident data were divided into different year sections, 1986-1995, 1995-1998 and 1998-2000. All data were supplied in the form of tables under different fields. Each field represented different types of information about each fire incident that occurred. The major fields were listed as the following:

1. Appliances
2. Casualty
3. Exp1 (general information)
4. Exp2 (rescue operation)
5. Exp3 (fire condition)
6. Exp4 (detection)
7. Exp5 (building description)
8. Exp6 (structure description)
9. Exp7 (flame)
10. Exp8 (background information)
11. Hazmat (hazardous material)
12. Incident
13. Vehicles

All data were linked together by the same key number for each incident, and the linking relationship for the database is shown below:

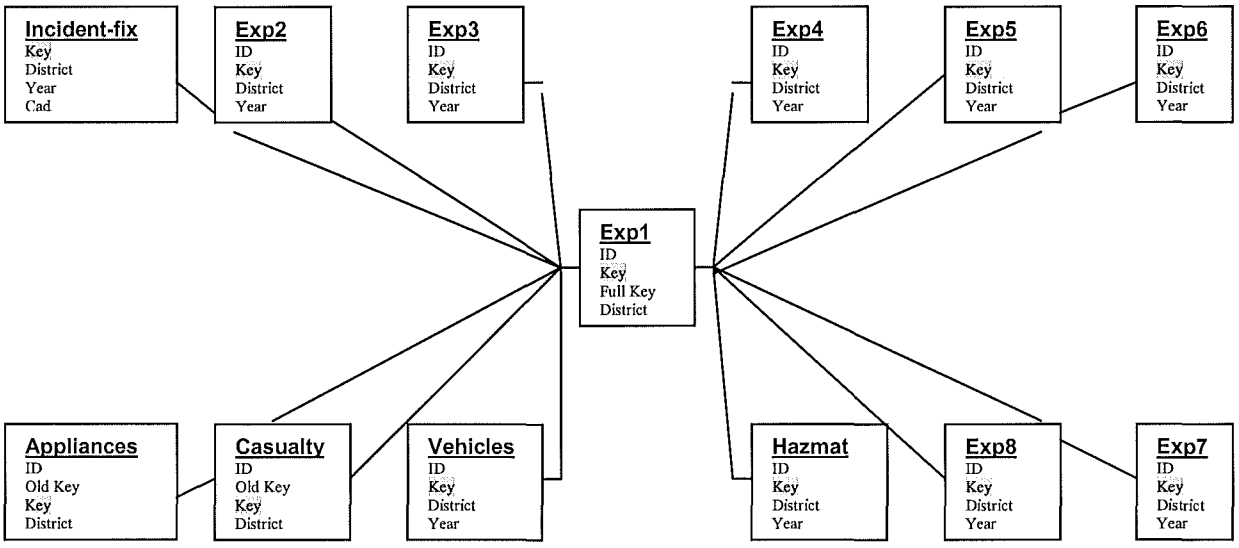

Figure 1 FIRS Datbase Relationship within Microsoft Access

3.3 Analysis Process

Since the data provided were all the incidents that had occurred for the past 15 years, to facilitate the purpose of this report the codes for specific property use have been used as an indication. A broader view had been adapted at first, then narrowed down as it went on. The approach taken was to look at the hospitality industry as a whole to find out the problems, then concentrated on the target area as time permitted.

The category "unknown" and "unable to classify" in some tables has been included in the analysis where it is necessary.

Results from the carried out analysis is presented in the following formats:

- Fire risk in terms of whole hospitality industry.
- Fire risk based on casualty hospitality fire incidents.
- Fire risk based on restaurant/café/diner fire incidents.
- Fire risk based on takeaway bars/lunch bars/fish & chips fire incidents.

3.4 Analysed Result Display

According to reference [2], information within the database is classified into different sections and under different headings. It has generally been classified using a broader term then a more specific term later on.

For example, the incident supposed cause could be firstly divided into smaller parts by the broader classification, which includes deliberately lit fires, recklessness, carelessness with heat source etc. Within each one of the broader classifications, it can be further divided into more specific terms, eg. Deliberately lit fire can be further divided into four different sections; unlawful, lawful, legality not known and suspicious.

For the purpose of this report, results of analysis are often grouped together according to the broader classification so that it is easier for the reader to see the difference. Each more detailed term are then displayed as tables in various sections through the report. The highest percentage of the specific terms is not necessarily a subset of the largest broader group.

3.5 Source of Uncertainty

1. During April 1996 fire-fighters took industrial action involving the non-completion of FIRS reports. As a result approximately 2300 incidents attended by the Fire Service are not recorded and therefore cannot be reflected in these statistics. [13]
2. It has been traditional for the Fire Service to only record casualty data relating to fire incidents. This has particularly been the case with injuries. With the increased emphasis on providing medical assistance there has been a dramatic increase in the number of public injuries being recorded. This appears to be entirely as a result of recording change rather than an increase in the number of fire injuries. [13]
3. In July 1995 the Fire Incident Reporting System was changed, which might have caused some mismatch and confusions for this report.
4. Some incidents had 2 key numbers (indicated by a difference in the last few digits), which appear in some tables but not all of them. This made the cross referencing hard and it was easy for mistakes to occur.
5. Some casualties were listed in the Casualty Table but not in the Exp1 Table (injury/fatality list) or vice versa, which made the analysis complicated and the calculation errors happen easily.
6. The assumptions made, eg. The unknown or unable to classify incidents had divided up according to the establishment proportion in some sections.
7. Errors carried out from background sources eg the Hot off Press Accommodation Survey.
8. There were lots of unknown or empty information in the original given database. Therefore, the analysis and conclusion were only made through those limited incidents rather than the whole population.
9. There were casualties missing from some of the tables but appear in the other tables, which might lead to confusion and uncertainty.

The scope of this report was controlled by the above guidelines, as well as by the time and the data available.

4 BACKGROUND ON HOSPITALITY INDUSTRY

New Zealand commercial industries could be divided into the following categories as their percentages were shown in Table 4 & Table 5. Among them, the hospitality industry stands for approximately 2.8% of the total commercial industries with about 9634 establishments and 87,298 employees on average each year, from 1991-1998. It is the 10th biggest industry and has the 9th highest employee number among the 18 major industries within New Zealand.

Table 4 New Zealand Commercial establishments number according to Fire Service Data 1991-1998

	Industry Description	Establish's	%	Rank
A	Agriculture	83763	24.4	1
L	Business Support	80610	23.5	2
G	Retail Trade	38999	11.4	3
E	Building Construction	34966	10.2	4
F	Wholesale Trade	19160	5.6	5
O	Medical	13448	3.9	6
Q	Miscellaneous	12919	3.8	7
I	Transport	11975	3.5	8
K	Finance	11027	3.2	9
H	Hospitality	9634	2.8	10
P	Recreation	9428	2.7	11
N	Education	7430	2.2	12
J	Communications	4069	1.2	13
C	Secondary Industry	2233	0.7	14
M	Government	2147	0.6	15
D	Utilities	679	0.2	16
B	Mining	537	0.2	17
Z	Undefined/Missing			
	TOTAL	**343024**		

Table 5 New Zealand Commercial establishments' employee number according to Fire Service Data 1991-1998

	Industry Description	Employees	%	Rank
C	Secondary Industry	258866	14.5	1
G	Retail Trade	222439	12.5	2
L	Business Support	201029	11.3	3
A	Agriculture	198465	11.1	4
O	Medical	143933	8.1	5
N	Education	122162	6.9	6
F	Wholesale Trade	114059	6.4	7
E	Building Construction	109817	6.2	8
H	Hospitality	87298	4.9	9
I	Transport	72279	4.1	10
M	Government	59950	3.4	11
Q	Miscellaneous	54356	3.0	12
K	Finance	52971	3.0	13
P	Recreation	41345	2.3	14
J	Communications	29816	1.7	15
D	Utilities	9690	0.5	16
B	Mining	4140	0.2	17
Z	Undefined/Missing			
	TOTAL	**1782615**		

4.1 FIRS Original Hospitality Database

The main areas that were extracted out from the original database were those with Hotel/Motel/Lodges and Restaurant/Pub/Tavern as the general property use. However, their SPUse were not defined as hospitality industry. They were divided up to show the proportions. For more detail please refer to Appendix A.

4.1.1 GPUse as Hotel/Motel/Lodges

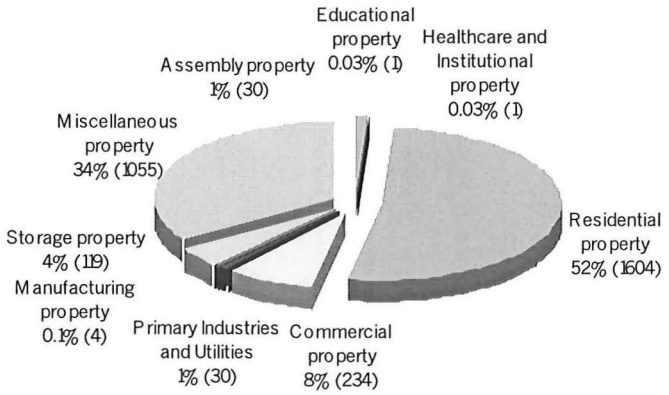

Figure 2 Hotel/Motel/Lodges as GPUse (divided by SPUse)

Note: as what have been discussed in previous section 3.4, Hotel/Motel/Lodges is a subset of the Residential property Category.

It is shown in Figure 2 that the highest proportion among all properties that are classified as Motel/Hotel/Lodges under its general property use fall into the residential property category when using its specific property use. Among all the residential properties, Hotel/Motel/Lodges with or without liquor license is 85% (the properties with GPUse and SPUse the same). Although all these incidents occurred in Hotel/Motel/Lodges according to their general property use, most of them are not going to be covered in this report. It was because they did not specifically happen on the hospitality portion of the property. The ones covered were mentioned in section 1.2 according to their specific property use. Only 60% of the Hotel/Motel/Lodges as GPUse fell into the defined hospitality industry according to the specific property use.

4.1.2 GPUse as Restaurant/Pub/Tavern

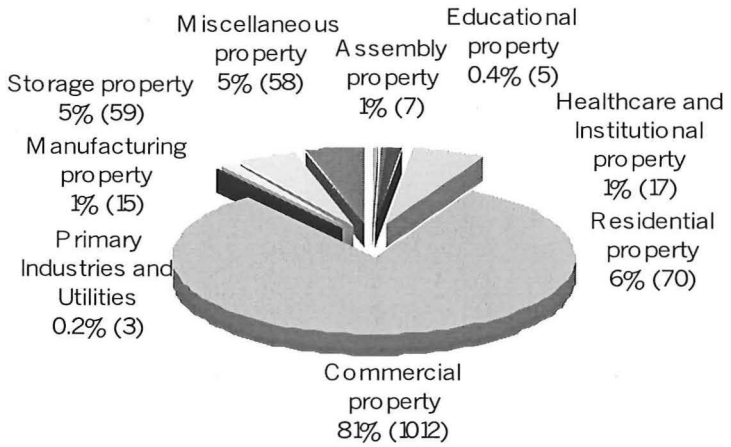

Figure 3 Restaurant/Pub/Tavern as GPUse (divided up by SPUse)

Note: as what have been discussed in previous section 3.4, Restaurant/Pub/Tavern is a subset of the Commercial property Category.

It is shown in Figure 3 that the highest proportion among all properties that were classified as Restaurant/Pub/Tavern under its general property use fell into the commercial property category when using its specific property use. Among all the commercial properties, Restaurant/Café/Diner, Sports clubs with restaurant, Pub/Tavern/Inn stand for 81% (the properties with GPUse and SPU the same). Although all these incidents that occurred in Restaurant/Pub/Tavern were named according to their general property use, most of them are not going to be covered in this report, since they did not actually specifically happen on the hospitality portion of the properties. The ones covered were mentioned in section 1.2 according to their specific property use. Only 68% of the Restaurant/Pub/Tavern as GPUse actually fell into the defined hospitality industry according to the specific property use.

4.1.3 Defined Hospitality Industry

According to the provided database which was extracted from the original/first fire report database of the New Zealand Fire Service, all of the above defined hospitality industry (specific property use) could be divided into the proportions shown below according to their general property use:

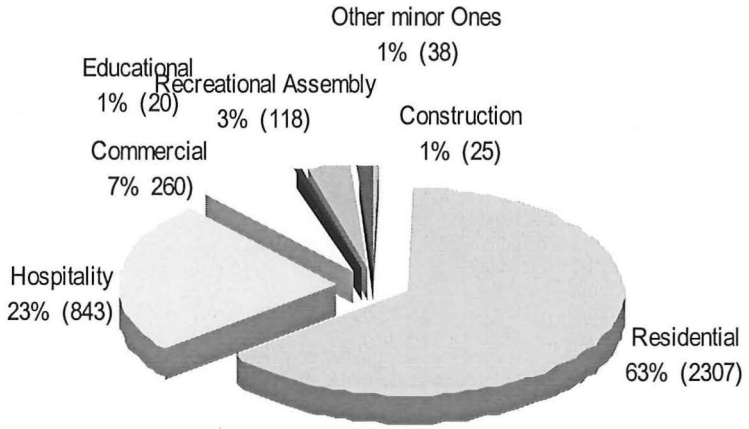

Figure 4 Hospitality Industry Category Distribution According to GPUse

It is shown in Figure 4 that most of the defined hospitality industry actually falls into the residential category (63%) and the hospitality category (23%). These two major categories cover Boarding house, Hotel, Motel, Lodges, Restaurant, Pubs and Taverns, which means most of the incident properties were classified under the same categories when using either General Property Use or the Specific property Use.

4.1.4 FIRS Original Database Casualty Fire Incidents

Table 6 Fire Incidents with Casualties 1986~2000

Property Type Description	InNo	%	CasNO	%	DeNo	%
Assembly	2	1.2	2	0.8	1	3.7
Other Residential	8	4.8	12	4.8	0	0
Other Commercial	16	9.6	19	7.6	0	0
Manufacturing	1	0.6	1	0.4	0	0
Storage	5	3.0	6	2.4	0	0
Other Miscellaneous	12	7.2	13	5.2	0	0
Hospitality	122	73.5	196	78.7	26	96.3
Total Incident with Casualty	166		249		27	

InNo – Incident Number CasNo – Casualty Number DeNo – Death Number

Since all Residential, Commercial and Miscellaneous categories covered the hospitality industry, all the fire incidents that had happened within the classified hospitality were extracted from the rest and formed a "Hospitality" category alone. All the rest of the incidents were left in the original category and named with "Other" in front.

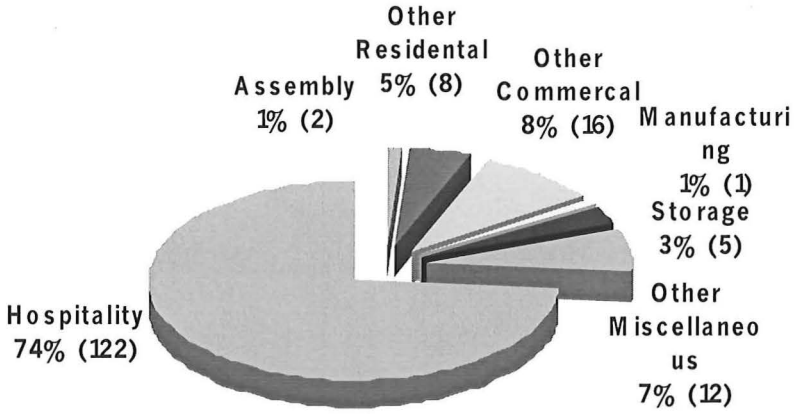

Figure 5 Fire Incidents with Casualty distributed by Incident Number

It is shown in Table 6 that not only do most of the fire incidents fall into the defined categories, but also most casualties did happen within the defined/covered area.

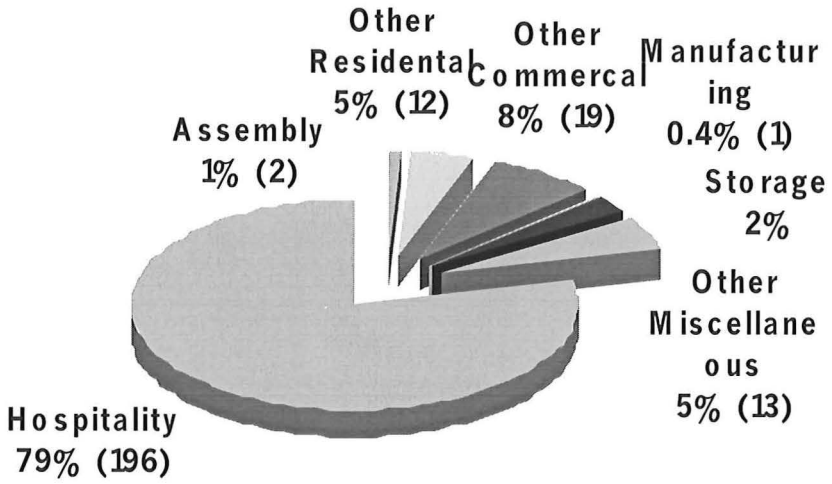

Figure 6 Fire Incident with Casualty distributed by Casualty Number

Figure 6 shows that not only has the hospitality industry the highest percentage of casualty fire incidents, the actual casualty number as a percentage for hospitality is even higher (78%).

The casualty and fatality numbers might not be high compared to some other bigger countries. For example, The MGM Fire in USA alone had 85 fatalities in 1980. But a lot of the fatalities might actually happen in the same incident, and it is still not acceptable and therefore needs to be improved.

4.2 Statistics New Zealand Accommodation Survey

4.2.1 About the Accommodation Survey

The Statistics New Zealand provides the following information. [14]

Note: this survey only reflects the short –term accommodation part of the hospitality industry.

A general short-term accommodation survey have been carried out throughout the country by Statistics New Zealand each month and published on their web site: www.stats.govt.nz, it is called the Hot off Press Accommodation Survey.

The target population for this accommodation survey was all establishments that were classified as short-term (less than one month) accommodation providers operating in New Zealand. In terms of the Australian and New Zealand Standard Industrial Classification (ANZSIC), the target population was taken from class 5710 (accommodation) and part of class 5720 (pubs, taverns and bars) that also provide accommodation. The survey frame was all the establishments having a turnover of at least $30,000 per annum.

The H5710 class (Accommodation) specifically consists of hotels, motels and similar units mainly engaged in providing short-term accommodation. Primary activities of H5710 units were (for the survey):

- Camping ground operation (although not included in class 5710 & 5720)
- Caravan park operation (although not included in class 5710 & 5720)
- Guest house operation
- Holiday houses and flats operation
- Hotel operation
- Motel operation
- Private hotel operation (short term accommodation)
- Ski lodge operation
- Youth hostel operation

77 percent coverage of the population was achieved; the remaining units were given imputed values based upon the characteristics of similar establishments in the same or similar regions Also only economically significant establishments are included, and some short-term accommodation as secondary commercial activities were not included. This procedure introduces unknown errors into the estimates along with other non-sampling errors.

4.2.2 Accommodation Survey Data

According to the Hot off Press Accommodation Survey May 1999-Sep 2000, the main parts of the accommodation industry did not vary much. Generally the peak was reached at around Summer time (Jan~Mar), and then started to fall.

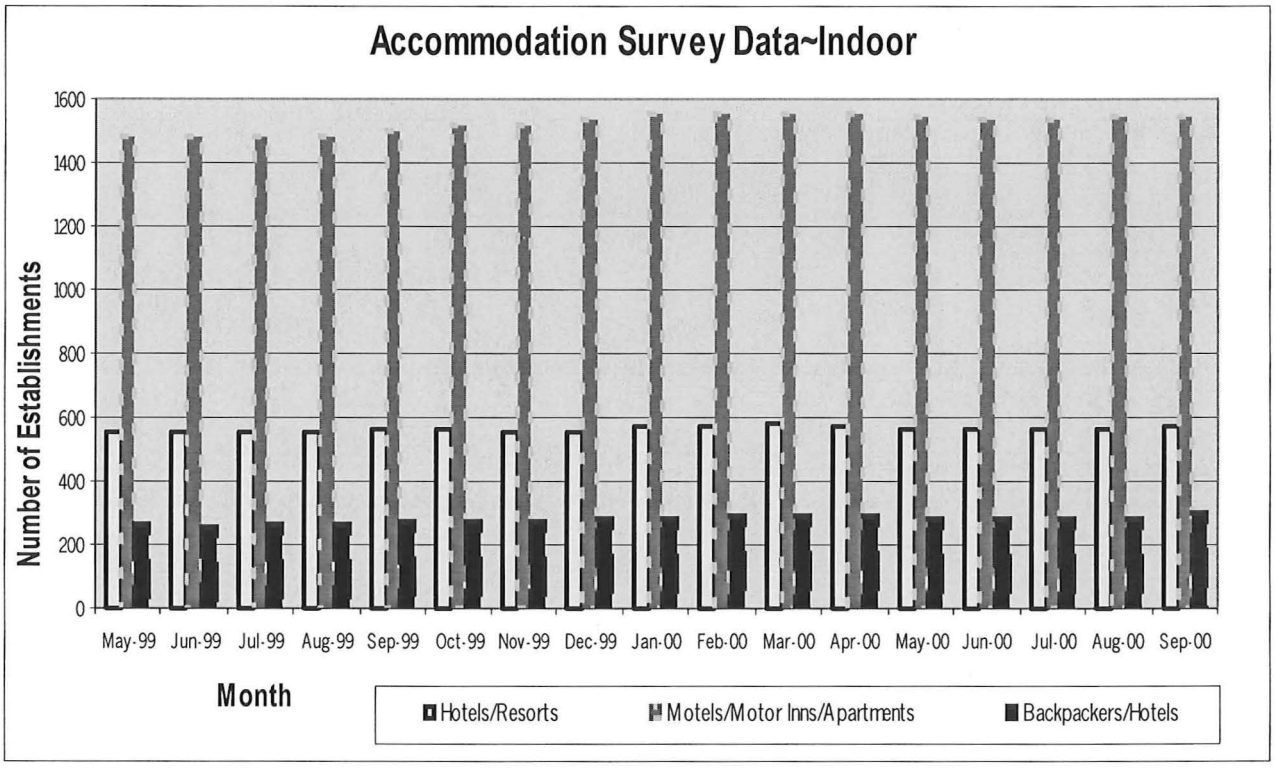

Figure 7 STATS NZ Accommodation Survey May 1999~Sep 2000 (Indoor)

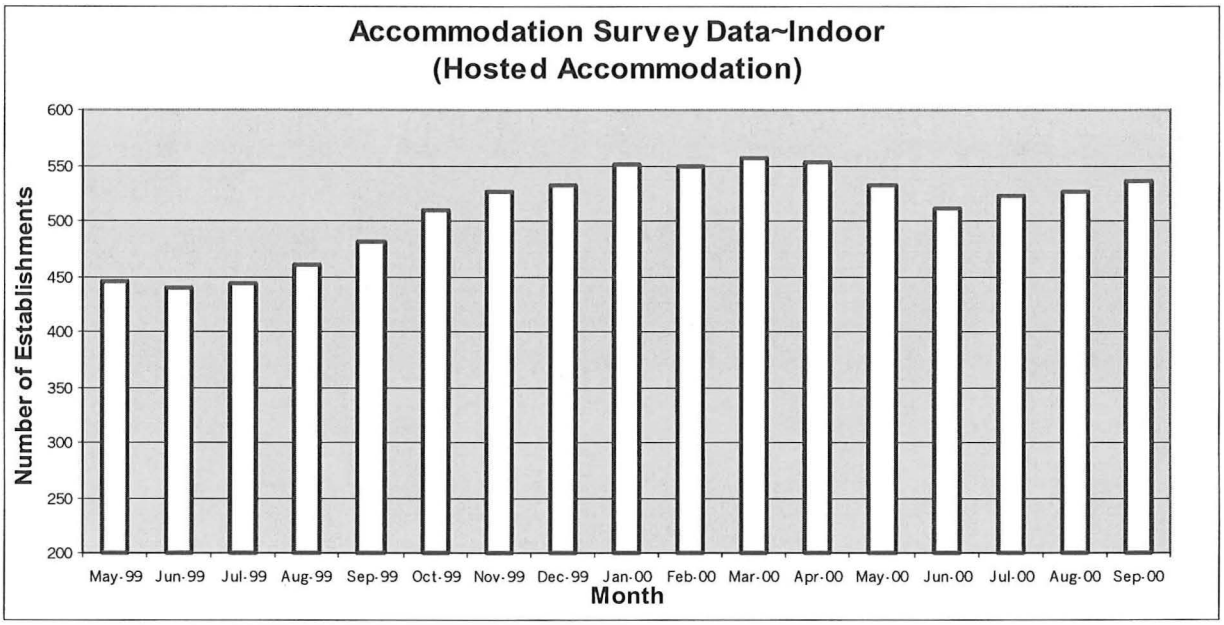

Figure 8 STATS NZ Accommodation Survey May 1999~Sep 2000 (Indoor/Hosted Accommodation)

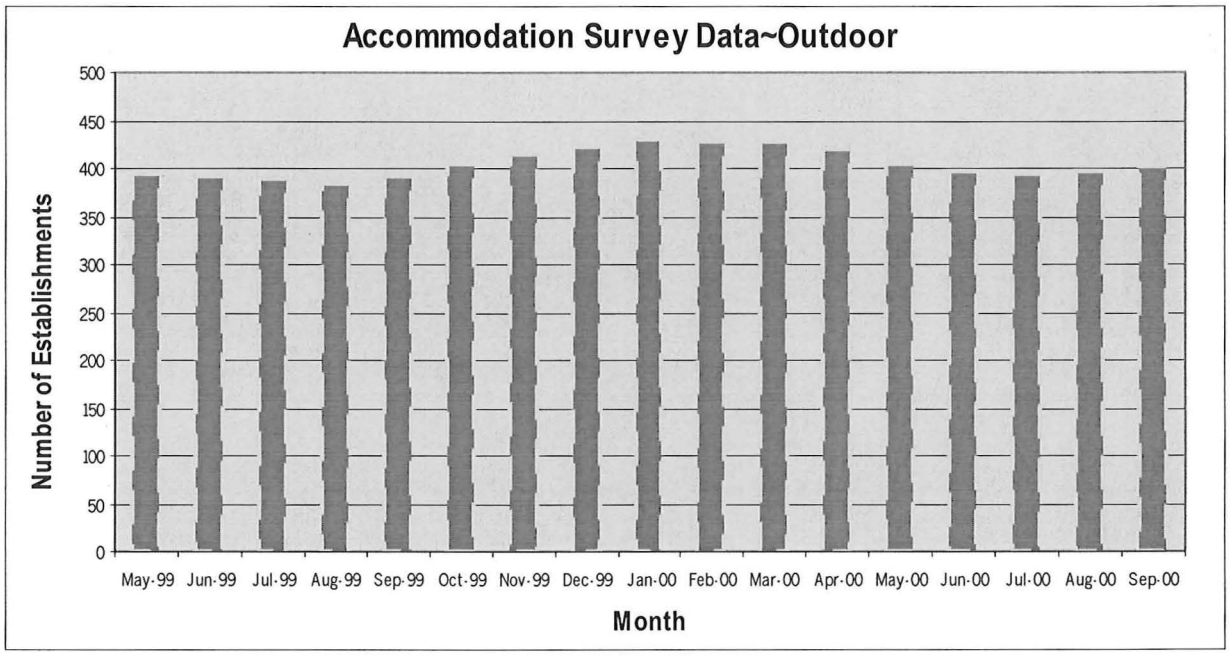

Figure 9 STATS Accommodation Survey May 1999~Sep 2000 (Outdoor)

Table 7 STATS NZ Accommodation Survey May 1999~ Sep 2000

Accommodation type	Average per month	%	s.d (establishments)	s.d (%)
Hotels/Resorts	563	17.2	7.1	1.3
Motels/Motor Inns/Apartments	1525	46.4	29.8	2.0
Hosted Accommodation	510	15.5	40.8	8.0
Backpackers/Hotels	279	8.5	10.7	3.9
Sub-Total without Caravan Parks	2877	87.6		
equivalent to Hotel/Motel/Lodges in FIRS classification				
Caravan Parks/Camping Grounds	406	12.4	15.3	3.8
the only exception from ANZSIC code				
Total Number of establishments	3284			

Table 7 shows that Motels/Motor Inns/Apartments have the highest percentage/portion (46.4%) out of the entire accommodation industry. The standard deviation for all the collected data are within 10%, the highest being the Hosted Accommodation with 8% standard deviation. If one looks separately into each subcategories of the accommodation survey, Motels/Motor Inns/Apartments and Hosted Accommodation have the highest variation, which could be as high as 100 establishments difference in terms of number.

5 GENERAL ANALYSIS

5.1 Comparison within Hospitality Data

Table 8 Comparison within Hospitality Fire Incidents

Hospitality Industry	Year 86~00		Year 99~00	
	#	%TI	#	%TI
4301 Boarding house	394	10.8	24	5.4
4303 University/School etc	2	0.1	0	0
4306 Bunk house/Workers'barracks	9	0.2	0	0
4399 Unable to classify rooming	21	0.6	0	0
4401 Hotel/Motel/Lodges with liquor license	644	17.6	127	28.4
4402 Hotel/Motel/Lodges without liquor license	909	24.9	39	8.7
5104 Restaurant/Cafeteria/Diner	986	27.0	175	39.1
5105 Sportsclubs with restaurants	30	0.8	7	1.6
5107 Pubs/Tavern/Inn	372	10.2	65	14.5
5108 Nightclub	89	2.4	8	1.8
9306 Campsites/Caravan sites/Campervan parks	196	5.4	2	0.4
Subtotal	3652		447	
Total NZ Fire Incidents throughout the years	**5621**		**623**	

 # - Incident Number %TI - percentage of total incident (from FIRS)

Calculations

All fire incidents which happened within the defined hospitality industry were extracted from the original database for further analysis.

%TI represents the percentage of each category of the total fire incidents happened within the specified years. From which, one could know the proportion of fire incidents within each category of the hospitality industry. Since the total hospitality fire incidents, which happened from 1986-2000, were 3652 cases, the percentage was calculated by incident number/ 3652.

Eg. 4401 Hotel etc with liquor license: %TI = 644/3652 = 17.6%

Commands

It is shown in Table 8 that the past year's hospitality fire incident proportion had jumped up in comparison with the last 15 years' average (243/yr) as indicated in the recent Fire Service Research (mentioned in the Introduction).

However, the table clearly shows that within the hospitality industry, Hotel/Motel/Lodges and Restaurant/Cafeteria/Diner had the highest portion of fire incidents. As for University/School etc, there were only two incidents over the last 15 years, the percentage is close to zero, and therefore it can be ignored in the detail analysis.

Note: for detailed analysis on Restaurant/Café/Diner fire incidents, please refer to section 8 of this paper.

5.2 Comparison between FIRS Data and the STATS NZ Accommodation Survey

5.2.1 General Comparison

As mentioned before in section 1.2, the hospitality industry could be further divided into smaller categories. One of the major categories was the Accommodation parts of the industry. According to the Hot off Press Accommodation Survey by the Statistics New Zealand, accommodation category can be divided into smaller parts, that the main purpose is to provide short-term accommodation. Therefore all the short-term accommodation were extracted and divided into smaller parts to make some comparison between the establishment number and the fire incident number.

Table 9 Short-Term Accommodation Fire Incidents

Short Term Accommodation type	Incident #	%	With Unclassified Data (%)
Hotels/Resorts	239	13.7	25.7
Motels/Motor Inns/Apartments	146	8.3	40.9
Hosted Accommodation	63	3.6	14.5
Backpackers	30	1.7	7.7
Caravan Parks/Camping grounds	196	11.2	11.2
unable to classify incidents	1075	61.5	-

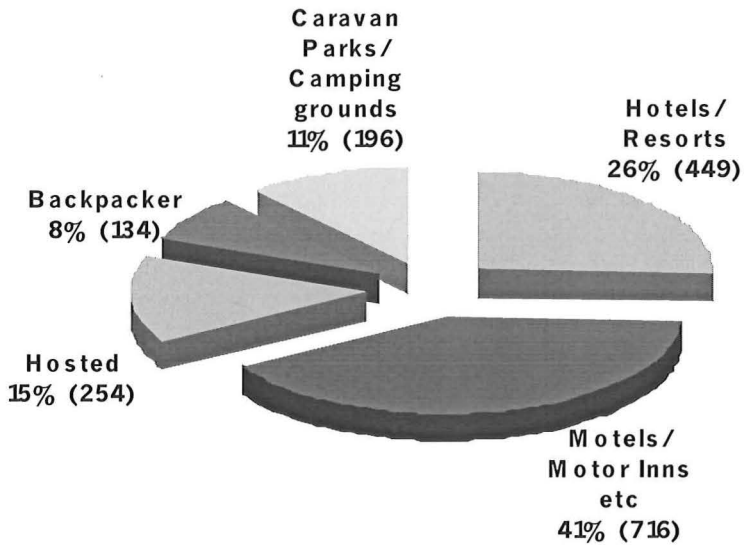

Figure 10 Distribution of Fire Incidents within the Short-Term Accommodation categories

Table 9 was tabulated from the FIRS database. However, in the FIRS database, each incident was classified under the New Zealand Fire Service's own coding system as discussed in section 1.2 (Table 2). The New Zealand Fire Service Coding system only subdivides the Hotel/Motel/Lodges category into two parts; those with or without a liquor license. It was not as detailed as what has been done for the Accommodation Survey (Table 7). Therefore further justification was required to group all incidents into the Accommodation Survey's sub categories in order for further comparisons to be done.

Justification was carried out by the following steps:

1. Extracting all the Hotel/Motel/Lodges (4401 & 4402) fire incident records out from the database along with the occupant names.
2. Classifying establishment type by occupant names. Eg Lincoln Hotel was classified under Hotel/Resort.
3. Assuming all occupant names, which had the term "House" at the end to be a hostel.
4. Assuming all occupant names, which were listed as people's name are B&B.
5. The coverage for each sub category are listed below:

   Hotel/Resort – Hotel + Resort

   Motel/Motor Inns/Apartments – Motel + Lodges + Inn

   Hosted Accommodation – Hostel + B&B

   Backpackers – Backpackers

   Caravan Parks/Camping Grounds – all fie incidents classified under "9306"

Note: Within the provided FIRS database, lots of the occupant names were left blank, therefore, they have been added in along with other unable to classify occupants according to the proportion of the total establishment number.

Eg. ILT is not decidable for the occupant/establishment type.

Say since Hotel/Resorts stands for 17.2% of the total short-term accommodation industry establishment number (Table 7), it was assumed that 17.2% of the unable to classify occupants were Hotel/Resorts.

Total Short-Term Accommodation fire incidents = 1744

Total named/classified short-term accommodation fire incidents = 669

Coverage = 38%

Although the accurate coverage was quite low along with the other possible errors within them, and although they might not be perfect for making conclusions, that was the best that could be done at this stage, however it can be used as a pointer for the direction of future research.

As mentioned before in Table 7, the short-term accommodation establishment number and percentage were repeated below, and a comparison could be made with Table 9:

Table 10 Short-Term Accommodation Establishment Numbers

Short Term Accommodation type	Establishment #	%	Incident #	%
Hotels/Resorts	563	17.1	449	25.7
Motels/Motor Inns/Apartments	1525	46.4	716	40.9
Hosted Accommodation	510	15.5	254	14.5
Backpackers	279	8.5	134	7.7
Caravan Parks/Camping grounds	406	12.4	196	11.2

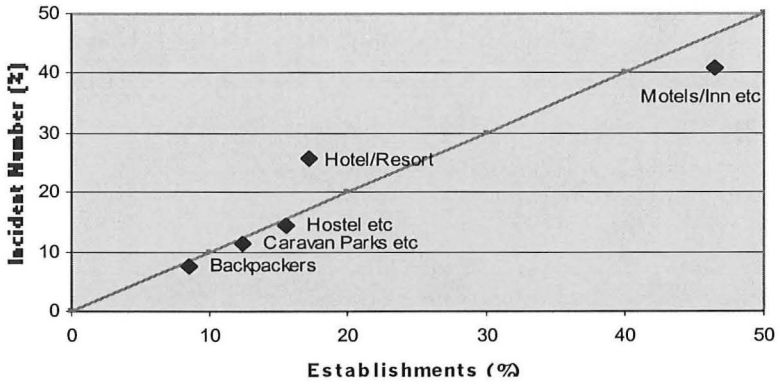

Figure 11 Short-Term Accommodation Fire Incident Trend

Figure 11 shows that there is quite a balanced relationship between the establishment number percentage and the fire incident number percentage for each subcategory of the short-term accommodation except for the Hotel/Resort and Motels/Motor Inns/Apartments categories. If it is a perfect match between the two percentages (x & y-axis), the graph should have a 45° angle straight line as shown on the graph, which the existing data shows quite a close match. The Hotel/Resort category has the most out-weighted fire incidents, which means according to the percentage of the total short-term accommodation's establishment number, it should not have that many fire incidents. In opposition to that, although the Motel/Motor Inn/Apartment category also experienced out-weighted fire experience, it is on the safe side, in other words as a percentage of the establishment number, it was expected to have more fire incidents than what it had at this point of time. Therefore it is important to find out the cause of out-weighted fire experience for this particular category.

5.2.2 Casualty Fire Incidents within Short-Term Accommodation

Using the STATS NZ Accommodation Survey data, all short-term accommodation fire incidents with casualty could be further divided into their own subcategories. Trends could be drawn from that and checked whether there was an unbalanced high percentage of casualties happening in a particular short-term accommodation type:

Table 11 Short-Term Accommodation Fire Incidents with Casualty 1986~2000

Hotels/Motels/Lodges category	Incident #	%	Add in Incident #	Add in %
Hotel/Resort	5	10.2	10	20.2
Motel/Motor Inn/Apartments	5	10.2	18	37.2
Hosted Accommodation	1	2.0	5	11.1
Backpackers	2	4.1	4	9.0
Unknown	25			
Sub-Total	38	77.6	38	77.5
Caravan	11	22.4	11	22.5
Total Short-Term Accommodation	49		49	

Due to the fact that NZ Fire Service FIRS data classified hospitality fires under different terms, in order for comparisons to be made, the actual occupant names had to be looked at and justified as to which STATS' category it belongs to. The justification method and process were carried out by what has been described before in section 5.2.1.

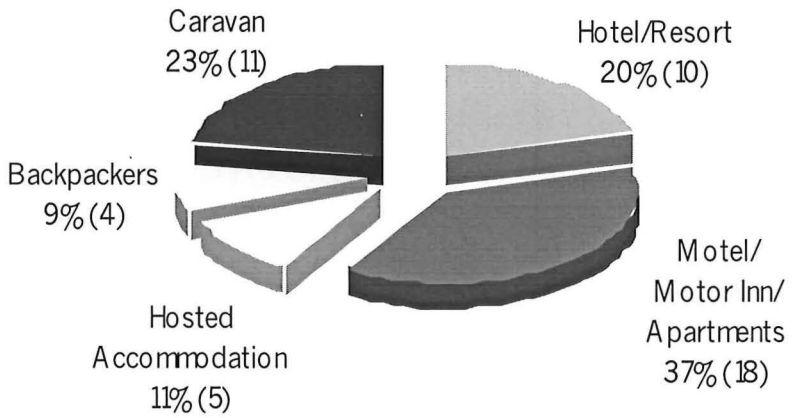

Figure 12 Short-Term Accommodation Fire Incidents with Casualty Distribution

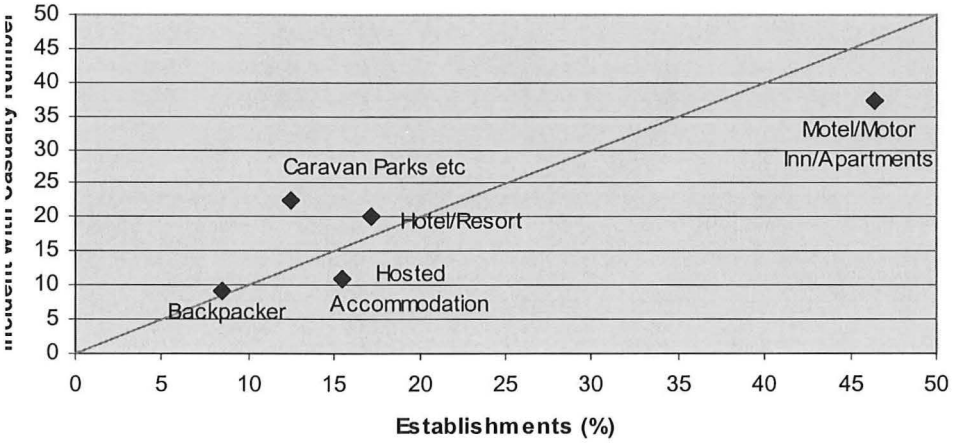

Figure 13 Short-Term Accommodation Fire Incidents with Casualty Trend

Figure 12 & Figure 13 shows that although Motel/Motor Inn/Apartments has the highest number of fire incidents with casualty among all the short-term accommodations, after a comparison with the percentage establishment number, the actual outweighed ones are Caravan Parks and Hotel/Resort. Backpacker is just right on the balancing point, which might also need to be further looked at.

5.2.3 Campsites/Caravan sites/Campervan parks Fire Experience

According to Table 7, Caravan parks/Camping grounds stand for 12.4% of all the short-term accommodation survey establishment number. On average, there are 11.2% (Table 9) fire incidents which happened within the category. It is not too far off from the expected percentage 12.4% (within the reasonable range). The percentage dropped dramatically for last year's data, it only stands for 0.4% of the total incidents within the same category as mentioned in the pervious section (Table 8).

Now the report explored more detail, concentrating on the Caravan park etc outdoor facility's fire incidents. The incident rate was plotted, which means the number of incidents per establishment, and caravan parks were compared with all the other accommodation type categories as below:

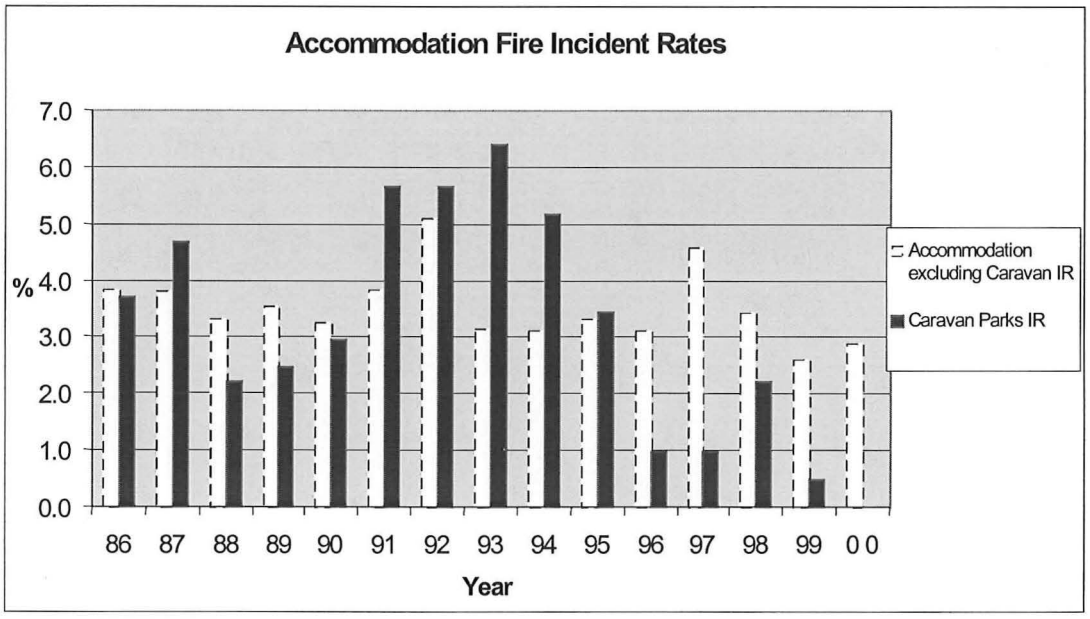

Figure 14 Comparison between Indoor $ Outdoor Accommodation Fire Incident Rate

It is shown in Figure 14 that the fire incident rate for the short-term accommodation industry varies a lot over the last few years. Indoor Accommodations (Accommodation excluding Caravan Parks/Camping Grounds) vary from 2.5%, the lowest, to 5% the highest. As for the Outdoor Accommodations (Caravan Parks/Camping Grounds), the variation is quite dramatic. For the past 5 years it dropped down to this year's low of 0% (up to Sep 2000) since 1993. As far as the author could find, there has been no legislation change with respect to caravan and fire safety. So long as the caravan is roadworthy and electrical and gas fittings are inspected and maintained according to the relevant regulations there is no requirement for fire safety on caravans. However, if the caravan becomes a permanent structure, as is becoming more popular, the caravan is then classified as a building and as such has to meet any relevant requirements of the Building Act (relating to fire spread to adjacent property). One possible explanation for this drop in incident numbers could be a raising of public awareness of the danger of fire in holiday setting from education provided by the Fire Service, but a great deal more research would be needed to get a firm correlation.

5.3 General Hospitality fire incidents information

5.3.1 Yearly Hospitality Fire Incidents

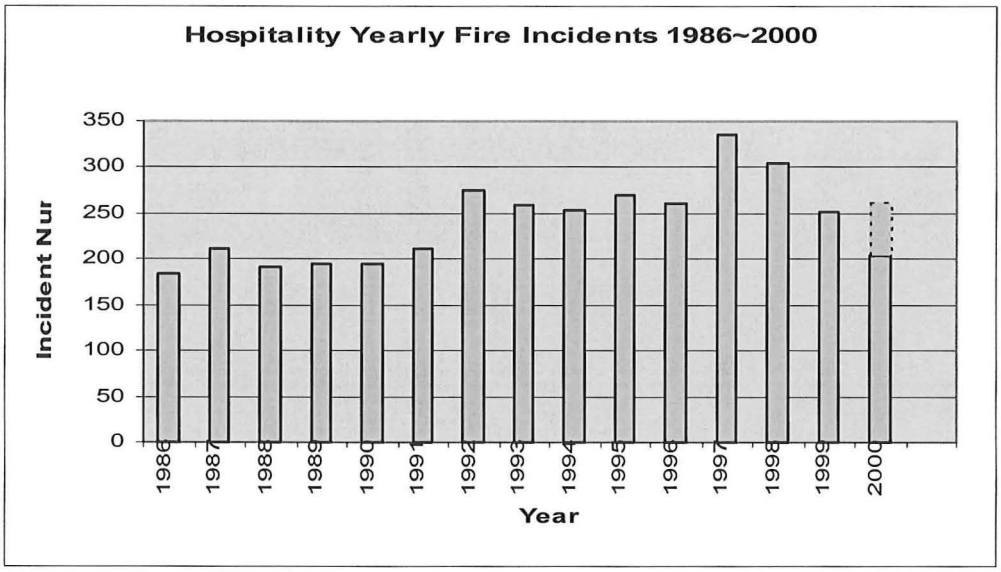

Figure 15 Hospitality Yearly Fire Incidents Comparison

Figure 15 shows that the number of fire incidents for the hospitality industry gradually increased from 1986's 184 incidents to a peak at 1997's 335, and then drops off again. The average incident number per year within the industry for the past 15 years is 240 incidents, the peak in 1997 has roughly 40% difference from the average, and the lowest value has approximately 23% difference from the average. Currently it is below the average and the number is 205 so far. According to the monthly trend over the past 15 years, it is expected to have another 57 incidents for the year 2000.

Since it was concluded from section 5.1 that Hotel/Motel/Lodges and Restaurant categories stands for the most fire incidents within the industry, the report concentrates on the yearly change of Hotel/Motel/Lodges at this point. Restaurant/Café/Diner is considered in a separate and more detailed section at a latter stage (Section 8):

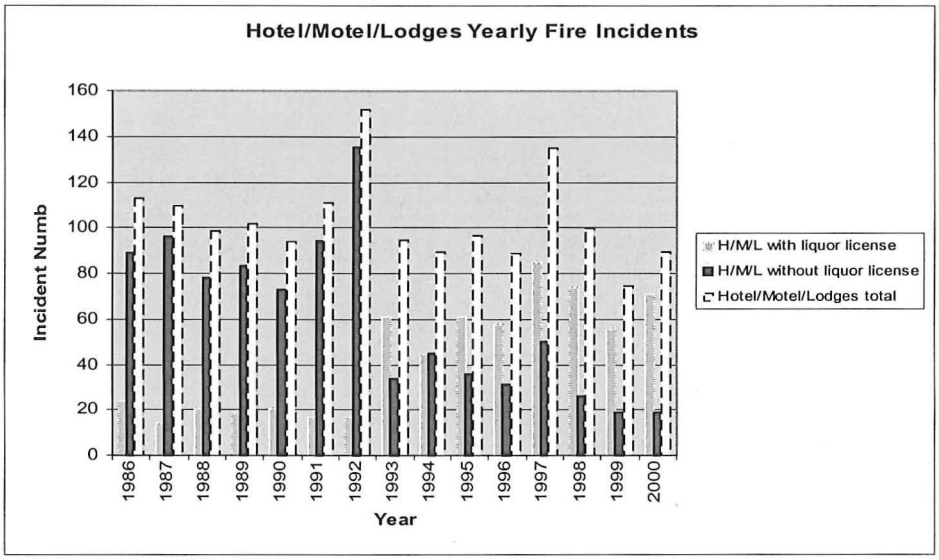

Figure 16 Hotel/Motel/Lodges Yearly Fire Incidents 1986~2000

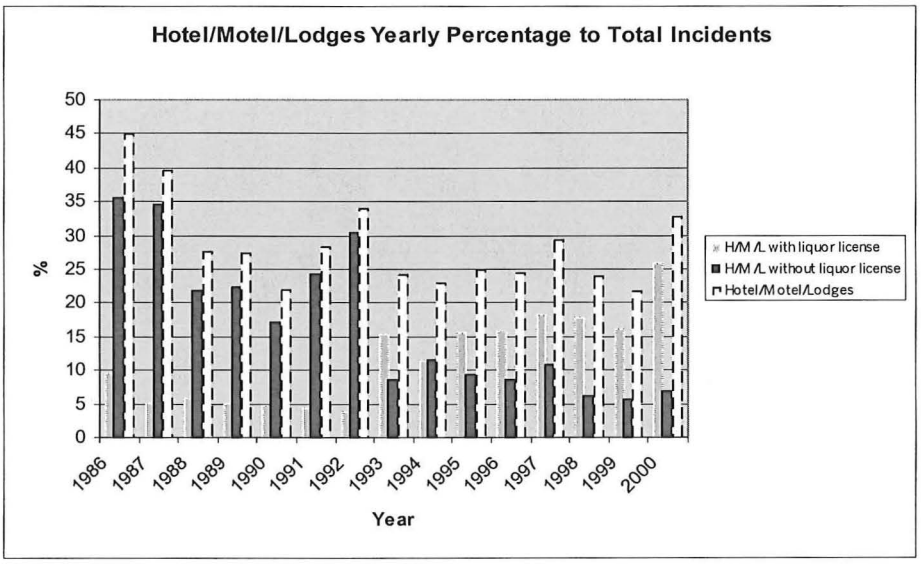

Figure 17 Hotel/Moteel/Lodges Yearly Fire Incidents as percentage to Total Fire Incidents

It is shown in Figure 16 & Figure 17 that Hotel/Motel/Lodges with liquor licenses had both a fire incident number and a percentage of the total increase over the last few years. Oppositely, the number and percentage of Hotel/Motel/Lodges without liquor license had dropped. Roughly speaking 1993 was the year of change. The reason for that is not at all clear. It is suspected that more hotels obtained licenses since 1993, but more detailed research would be necessary to reach a conclusion.

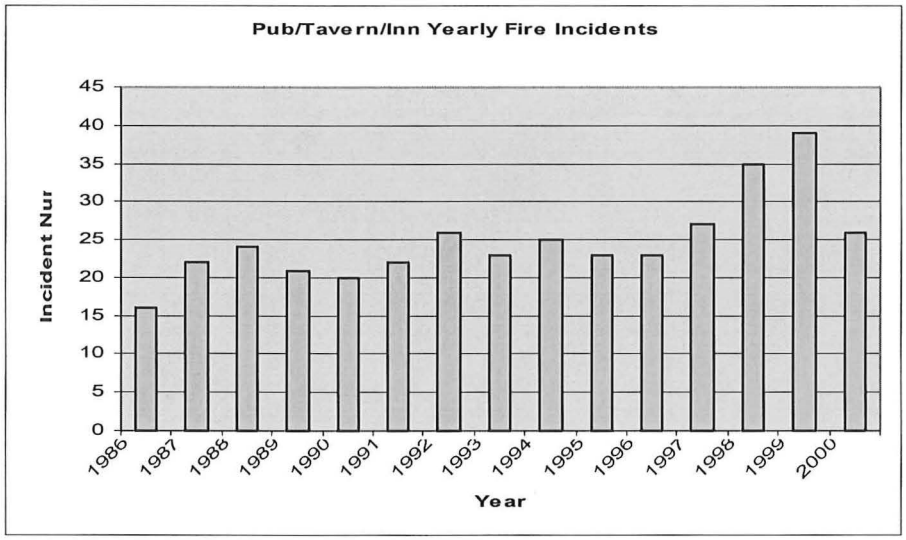

Figure 18 Pub/Tavern/Inn Yearly Fire Incidents 1986~2000

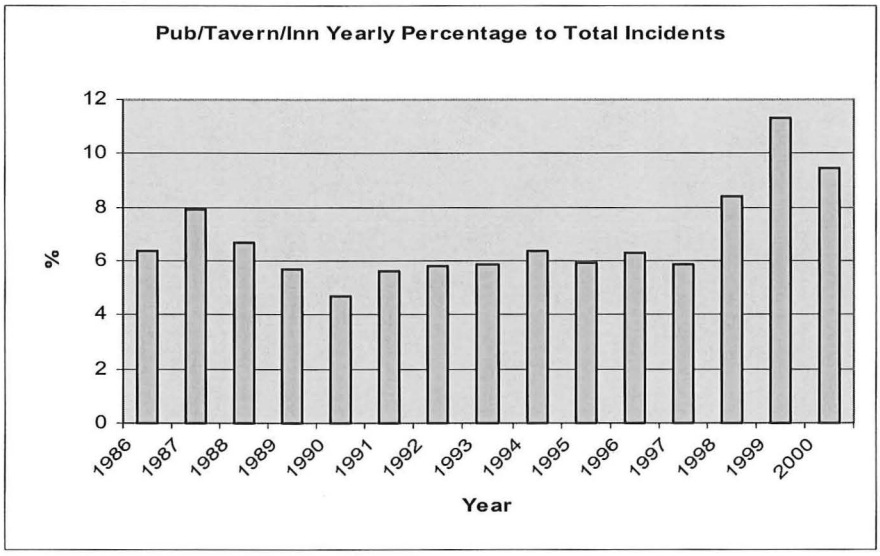

Figure 19 Pub/Tavern/Inn Yearly Fire Incidents as percentage to total fire incidents

Pub/Tavern/Inn category has also been further looked at since it was indicated in section 5.1 that it had slightly increased in percentage. Figure 18 & Figure 19 shows that both fire incident number and percentage of Pub/Tavern/Inn did have an increase since 1997, but dropped again in 2000 (data provided only up to Sep 2000).

5.3.2 Monthly Hospitality Fire Incidents

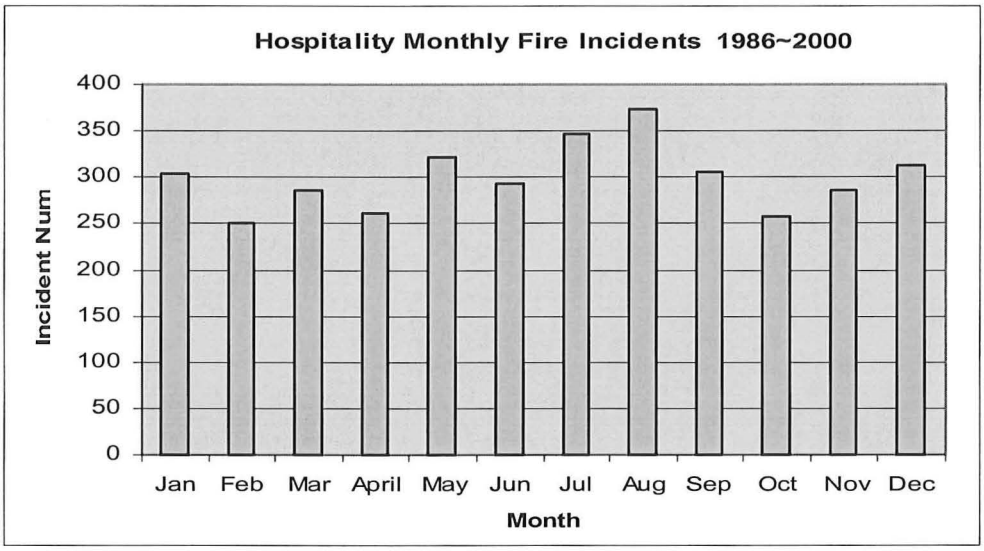

Figure 20 Hospitality Monthly Fire Incidents Compatison

Figure 20 shows that all hospitality fire incidents happen evenly throughout the year. There is no particular month, which has an extremely high or low incident number. However, a slight difference could still found. Generally the average incident number per month for the past 15 years in total is 300 incidents. The peak incident number happens in August with 373 incidents and the lowest incident number happens in February with 251 incidents.

The monthly graph below was further separated by years and the difference could be found:

Table 12 Hospitality Monthly Fire Incident Data for Year 1986~ Sep 2000

Month	86	87	88	89	90	91	92	93	94	95	96	97	98	99	0
1	14	12	18	18	13	21	20	25	15	24	14	32	34	28	16
2	11	11	10	15	12	14	14	16	20	18	18	22	30	22	18
3	10	18	13	13	20	15	21	25	16	23	25	23	24	17	24
4	14	11	12	15	15	17	17	24	28	15	10	22	22	19	21
5	13	25	18	17	11	13	31	22	26	25	28	23	23	18	29
6	17	21	13	20	16	17	18	16	23	20	18	29	19	22	24
7	20	17	18	15	22	22	29	30	24	22	25	22	28	24	29
8	24	18	20	20	18	25	23	26	23	33	22	33	26	36	26
9	18	17	15	10	16	16	16	20	18	28	31	35	26	21	18
10	8	17	20	16	16	14	28	14	16	25	15	27	23	18	-
11	14	18	16	16	11	18	42	17	26	15	25	22	29	18	-
12	21	25	18	20	25	20	17	24	18	21	30	45	20	9	-
Peak	24	25	20	20	25	25	42	30	28	33	31	45	34	36	29
Lowest	8	11	10	10	11	13	14	14	15	15	10	22	19	9	16

Shaded parts are the max and min data for the years

Table 11 shows that in the past 15 years, almost half of the peak fire incident number happened in August, which is the winter season of New Zealand. It is quite surprising because one would normally expect that summer time to be the high risk season for fire due to the dry weather and high temperature environment. Then again, the peak could be related to the higher frequency of heating device usage in winter season. Further, because it was during NZ school holiday period when there would be more reckless young students outside of school.

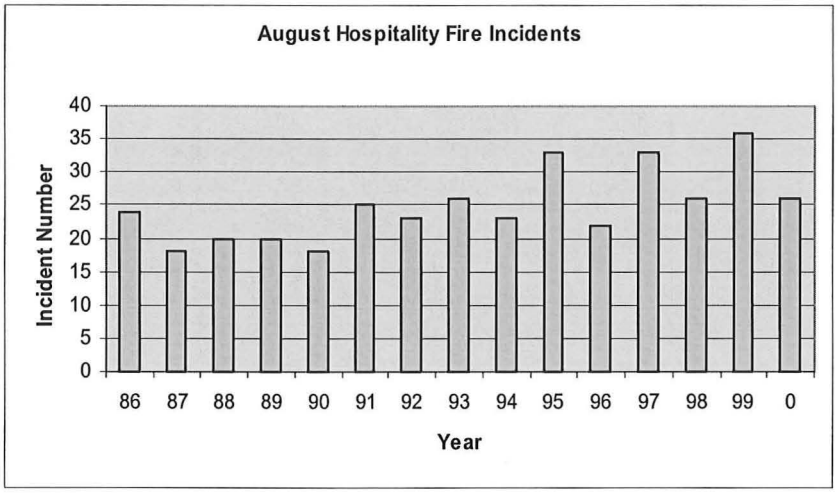

Figure 21 August Hospitality Fire Incidents 1986~2000

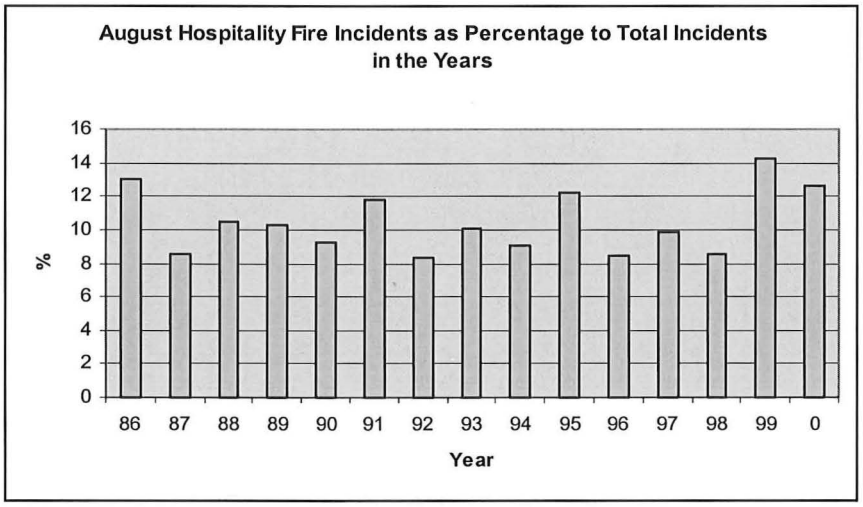

Figure 22 August Hospitality Fire Incidents as percentage to the years' total fire incidents

On average August has 24.9 incidents each year, the peak year being 1999, which had 36 incidents. In percentage to the total fire incidents, August stands for 10.4% of the yearly fire incidents on average, which is quite high. If it is balanced between the months, each month should only have 8.3% of the total yearly fire incidents. From the above fire incident number graph, there is no extreme trend for August fire incidents, but it seems that whenever there is a high incident number year, the next one would drop a lot then go up again as a cycle like the last 6 years (Figure 21). But this trend is not that obvious in the percentage graph. If one just looks at the fire incident percentage graph, the percentage has jumped a lot for the past 2 years, even to a high of 14%.

Now the report took a closer look at 1997's data, since it was the year with the highest fire incident number:

Figure 23 1997 Hospitality Fire Incidents

Figure 23 shows that the peak incident number did not happen in August. However, it did have a fire incident numbers on the high side compared to all the other months.

5.3.3 Hospitality Fire Incident Types 1986~2000

Table 13 Hospitality Top 5 Incident Types 1986~2000

Incident Type	#	%
1101 structure damage occurred	1382	37.8
1102 no structure damage occurred	982	26.9
1104 chimneys	251	6.9
1501 rubbish (outside)	236	6.5
1599 unable to classify miscellaneous fires	211	5.8
Other Minor Incident Types	590	16.1

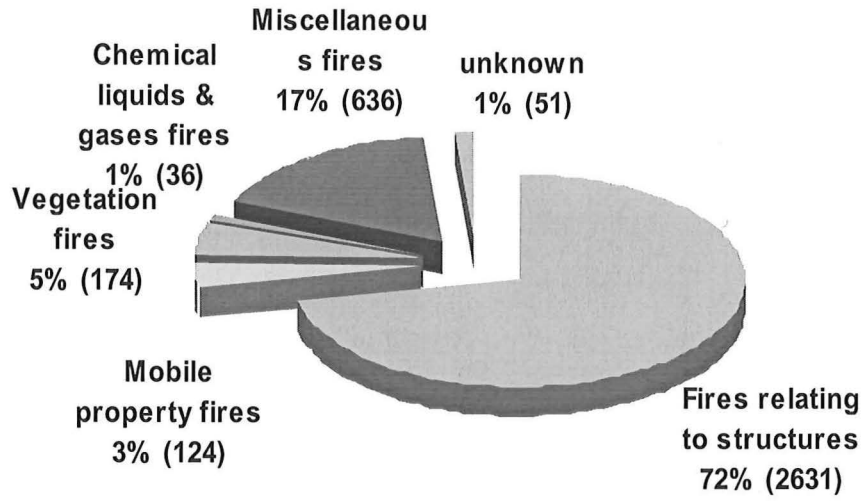

Figure 24 Hospitality Fire Incident Types 1986~2000

It is shown in Figure 24 & Table 13 that Incident Type 1101 and 1102 stand for the highest percentage within the hospitality industry. Those two incident types are fires relating to structures (eg. buildings, factories, shops, house, garages and sheds), whether structural damage occurred or not. This includes most fires inside the structure except derelict buildings and chimneys. Chimneys occupied the third place and have as high as 7% of all the hospitality incidents.

Structure fires stand for more than half of the hospitality industry fire incidents as one would probably expect (73%). Most heat sources are inside the structure, so they caused the most hazardous fire as they were within the structure/confined building. The remaining parts of the industry's fire incidents are made up by vehicle, vegetation and miscellaneous fires, which are probably not that important in terms of casualty and damage.

5.3.4 Hospitality Fire Incident Supposed Causes

Table 14 Top Causes for Hospitality Fire Incidents for 1986~2000 (specific classification)

Cause	#	%
311 careless disposal	269	7.4
114 suspicious	239	6.5
715 failure to clean	237	6.5
999 unable to classify other supposed cause	224	6.1
713 equipment unattended	216	5.9
111 unlawful	211	5.8
514 short circuit etc	206	5.6
under investigation/empty	206	5.6
515 other electrical failure	199	5.4
Other minor causes	1851	45.2

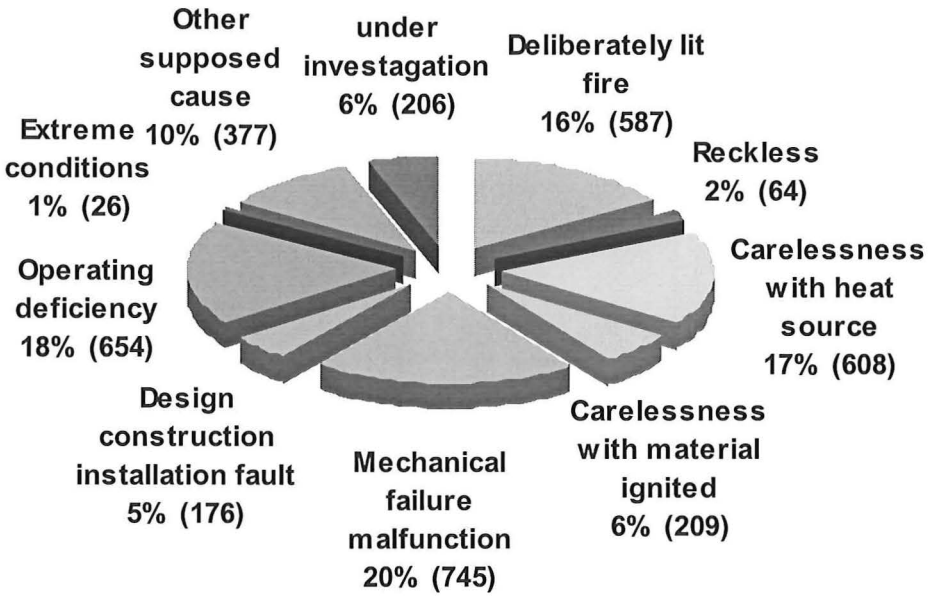

Figure 25 Hospitality Fire Incident Causes (border classification)

Table 14 & Figure 25 shows that within New Zealand's Hospitality Industry, there are several major causes, which dominate the fire incidents. They are operating deficiency, mechanical failure malfunction, and carelessness with heat sources and deliberately lit fires as a broader group. However according to section 3.4 classification method, the number one specific cause in the industry is careless disposal, followed by suspicious and failure to clean as the top three causes without counting the unknown causes. It is important to note these causes in order to prevent them.

5.3.5 Hospitality Fire Incident Construction Types

Table 15 hospitality Fire Incident Comparsion Types

Construction Types	Incident Number	%
9 Unable to classify/Unknown	999	42.3
8 Timber frame unprotected (normal housing)	593	25.1
1 Fire resistant	383	16.2
7 Timber frame protected	108	4.6
4 Reinforced concrete with combustible cladding	105	4.4
3 Reinforced concrete with non-combustible cladding	102	4.3
2 Heavy timber	52	2.2
6 Metal frame unprotected	18	0.8
5 Metal frame protected	4	0.2

Note: not all the hospitality fire incidents were provided with construction type data

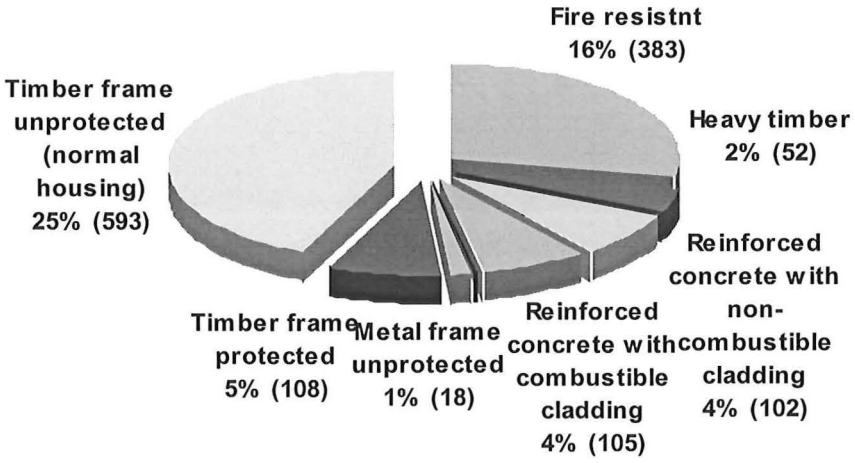

Figure 26 Hospitality Fire Incident Construction Types Distribution

Note: Unable to classify/Unknown Construction Types was not included in this Figure

It is shown in the above Table 15 & Figure 26 that more than half of the fire incidents happened in properties constructed by unprotected timber frame in New Zealand hospitality industry. The second most common construction type with fire incidents is the fire resistant construction, but no fatality has occurred in this category.

Table 16 Hospitality Fire Incidents with Specific Property Use & Construction Type

Hospitality Property Use/Construction Types	1	2	3	4	5	6	7	8	9
4301 Boarding house	16	5	2	3	0	3	14	137	1
4306 University/School etc	0	0	0	0	0	0	0	7	0
4399 Unable to classify rooming	1	0	2	0	0	0	1	6	0
4401 Hotel/Motel/Lodges with liquor license	62	9	17	14	0	1	19	93	4
4402 Hotel/Motel/Lodges without liquor license	119	14	29	35	1	3	32	171	1
5104 Restaurant/Café/Diner	119	14	39	37	2	7	26	101	2
5105 Sportsclubs with restaurant	1	0	1	1	0	1	0	3	0
5107 Pubs/Tavern/Inn	41	5	5	10	0	1	12	49	0
5108 Nightclub	22	4	6	5	0	0	1	11	0
9306 Campsite/Caravan sites/Campervan parks	2	1	1	0	1	2	3	15	1

Table 16 shows that Boarding houses have the highest unprotected timber frame construction fire incident. Furthermore, Hotel/Motel/Lodges without liquor licenses and Restaurant/Café/Diner have the highest fire resistant construction fire incident.

It is important to note the different usage of construction types for different hospitality categories in order for improvements to be made. At the moment, each incident's construction type has been given. A possible reason was that the industry has certain common construction type. If 90% of the boarding houses were constructed by concrete, the problem could be manageable, so long as 90% of the fire incidents within that category were related to concrete structure. Further research is required on this point.

5.3.6 Hospitality Fire Incidents' Casualties and Fatalities

Note: Casualty defined as injuries along with fatalities. Injuries comprise of those sustained by fire-fighters and civilians.

The following are the distribution of hospitality fire incidents with casualty over the years 1986~2000:

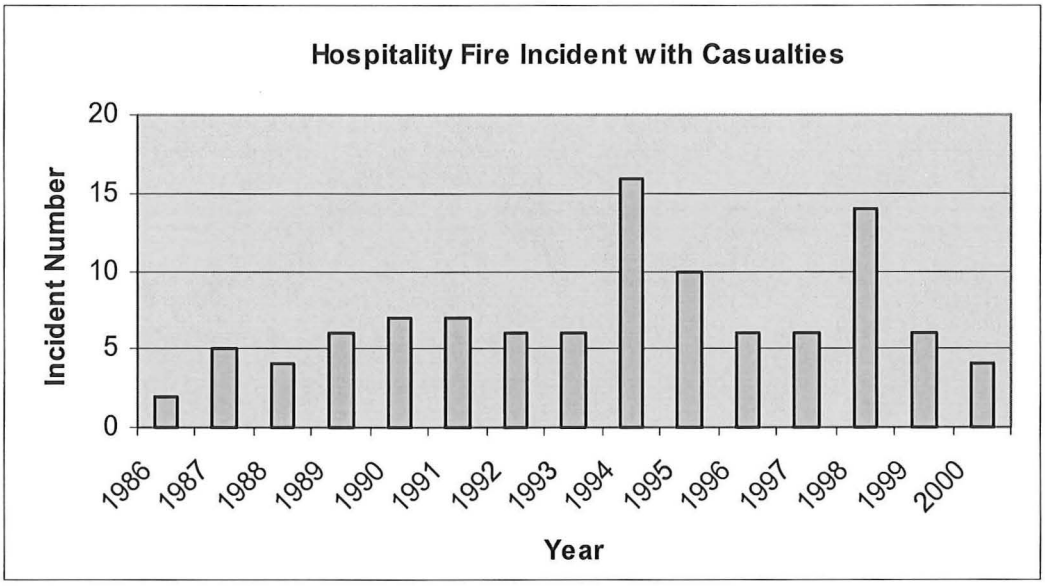

Figure 27 Hospitality Fire Incidents with Casualty

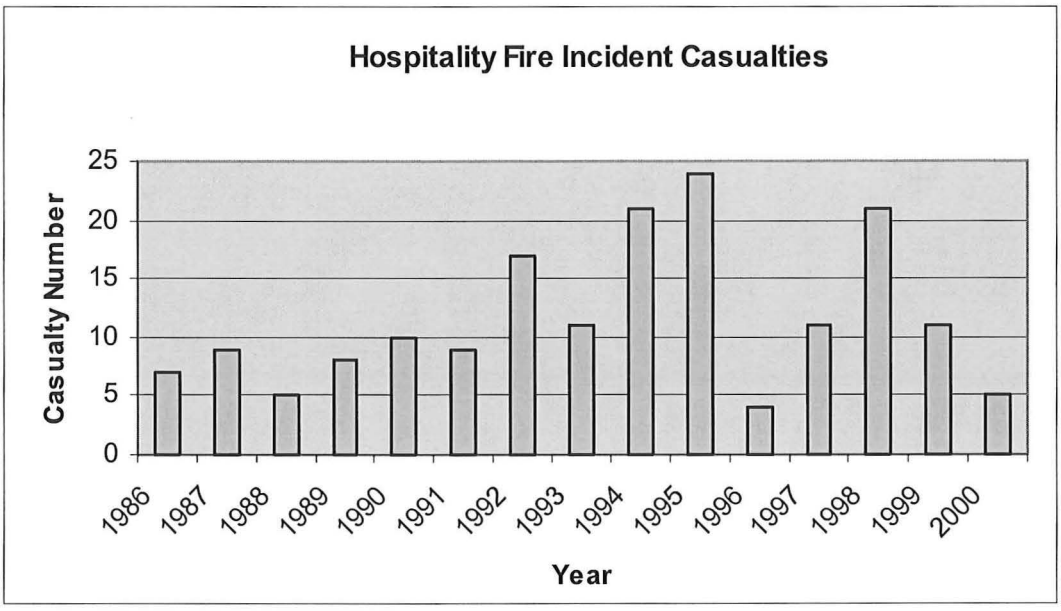

Figure 28 Hospitality fire Incidents with Casualty

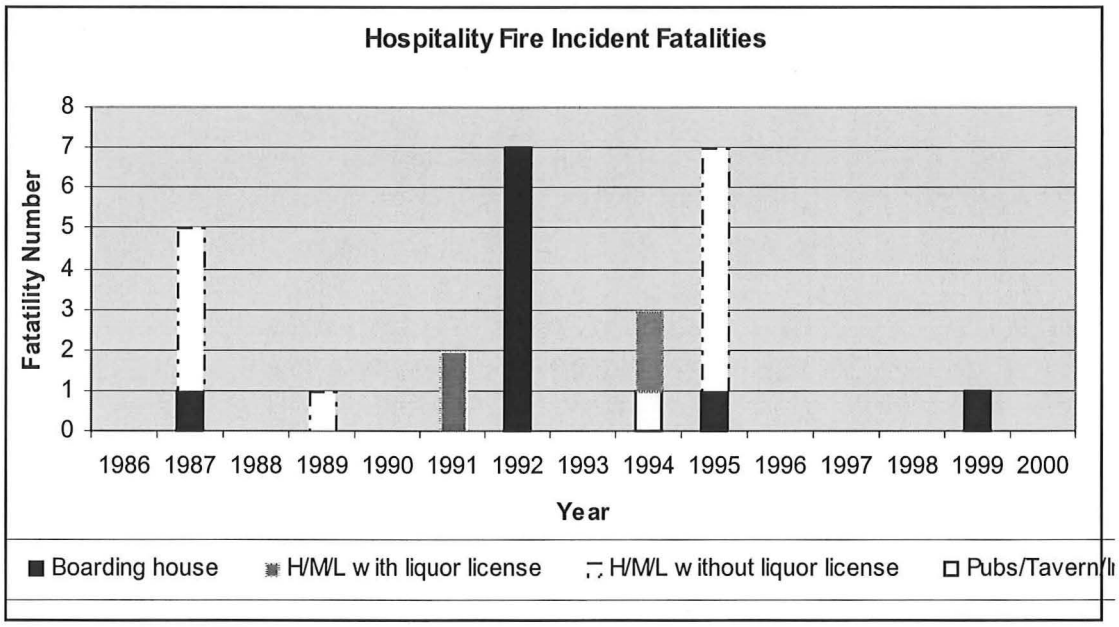

Figure 29 Hospitality Fire Incidents with Fatality

It is shown in the above Figures (Figure 27 & Figure 28 & Figure 29) that in 1995 and 1998 there were a lot of casualty fire incidents, but not that many fatalities occurred. The peak fatality number occurred in 1987 with 7 people dead. It is notable that it seems like a loop going on since 1994. We might summarise that whenever there is a lot of incidents with casualty then the media will turn its attention on them and the public would become aware of the importance of fire protection and prevention. The incident numbers continued to drop for few years. As time went on, the incident number goes up again, as less public attention is attracted.

The Hospitality industry could be further divided into smaller categories according to the New Zealand Fire Service FIRS Code:

Table 17 Hospitality Industry Fire Incidents with Casualty 1986~2000

Hospitality Industry	Incident #	%	CasNo	%	DeNo	%
Boarding house	23	18.9	50	25.5	10	38.5
Bunk house/worker's barracks	1	0.8	1	0.5	0	0.0
Hotel/Motel/Lodge with liquor license	19	15.6	30	15.3	2	7.7
Hotel/Motel/Lodge without liquor license	23	18.9	45	23.0	11	42.3
Restaurant/café/diner	33	27.0	39	19.9	0	0.0
Sportsclubs	2	1.6	2	1.0	0	0.0
Pub/tavern/Inn	7	5.7	12	6.1	1	3.8
Nightclub	2	1.6	2	1.0	0	0.0
Caravan	12	9.8	15	7.7	2	7.7
Total Hospitality	**122**		**196**		**26**	

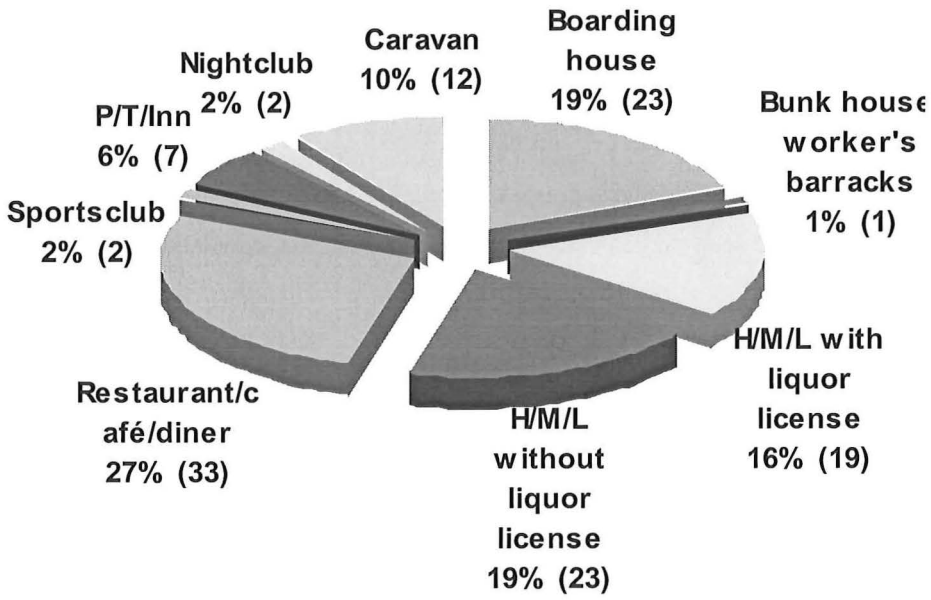

Figure 30 Hospitality Fire Incidents with Casualty distubted by Incident Number

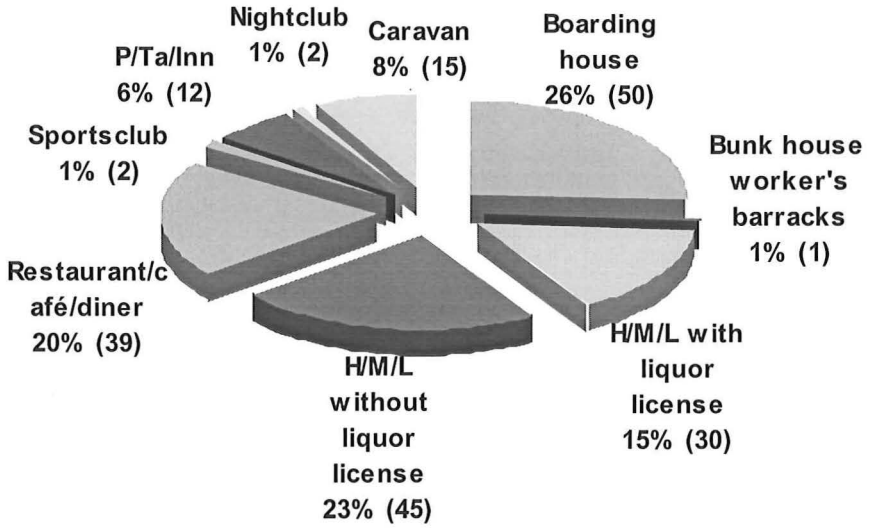

Figure 31 Hospitality Fire Incidents with casualty distributed by Casualty Number

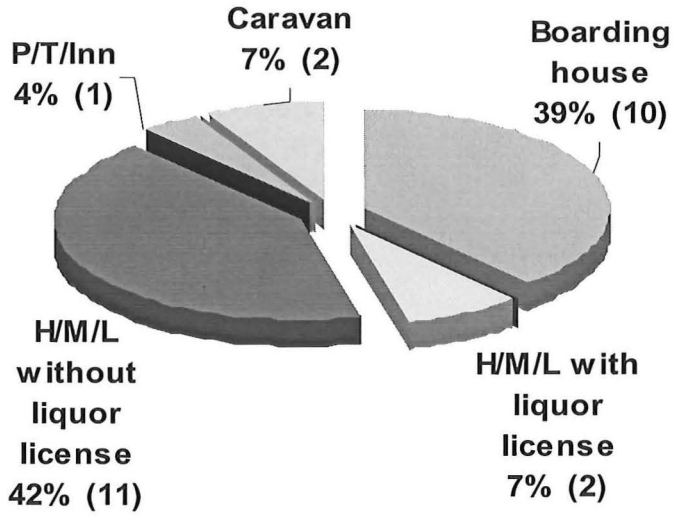

Figure 32 hospitality Fire Incidents with Casualty distributed by fatality Number

It is shown in the above Table and Figures (Table 17, Figure 30, Figure 31 & Figure 32) that Restaurant/Café/Diner has the most fire incidents with casualty but no fatality has happened within the category. All fatalities have happened in the accommodation type categories rather than the other hospitality industry categories. Hotel/Motel/Lodges without liquor license & Boarding house have the highest percentage at 44%. This report will concentrate on casualty fire later in Section 6.

5.3.7 Hospitality Fire Incidents' Fire Origins

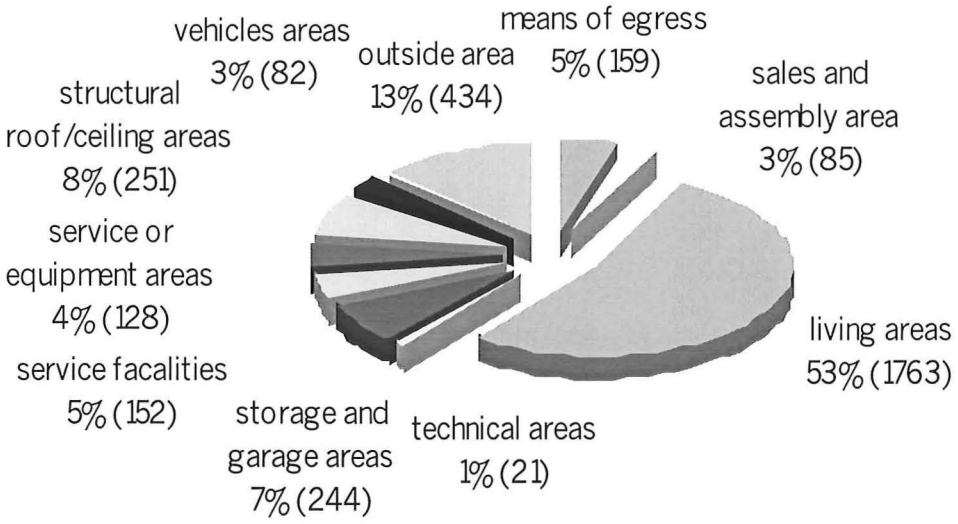

Figure 33 Hospitality Fire Incidents' Fire Origin

It is shown in Figure 33 that more than half of the hospitality fire incidents originated in living areas. Within the living areas, the largest proportion of fire incidents started from the kitchen (24%) followed by bedroom fires (9.7%). Most kitchen fires were related to food providing establishments such as restaurants.

5.3.8 Hospitality Fire Incidents' Heat Sources

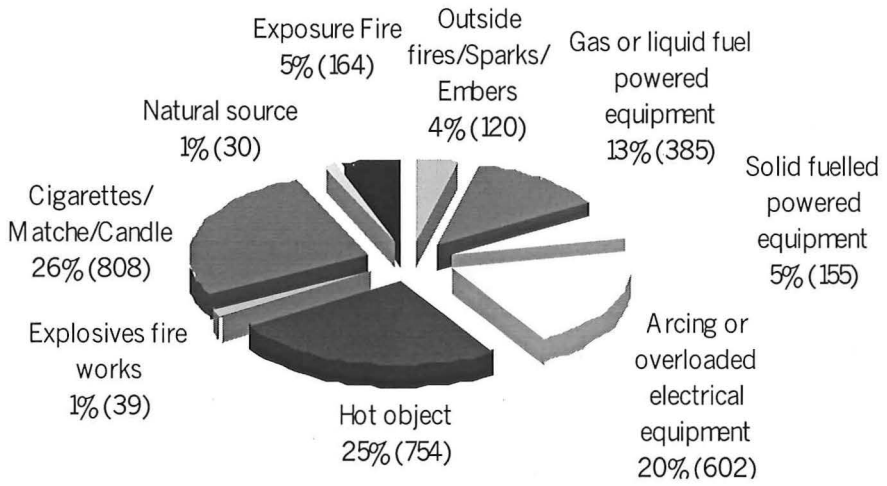

Figure 34 Hospitality Fire Incidents' Heat Sources

Figure 34 shows that the largest proportion of fire incident heat sources is the group of Cigarettes/Matches/Candles. Taking them separately (as the method discussed in section 3.4), the greatest single heat source for hospitality fire incidents is heat from electrical equipment (properly operated) followed by heat from gas fuelled equipment, which reflect what has been suspected about the increased usage of heating devices.

5.3.9 Hospitality Flame Damage

Note: the following section of the report was followed by reference [15]'s defined method.

In ascertaining the risk by types of fires, the following classification has been adopted.

Table 18 Types of Fire

Flame Damage Category (Extent of Flame)	Type of Fire
0 and 9	Omitted for this part of report
1 and 2	Smouldering
3 and 4	Non-flashover fire
5 to 8 (inclusive)	Flashover fire

Following the above Table, fire types could be divided into three major categories, including smouldering, non-flashover and flashover fires. The classifications were carried out using the extent of flame damage to the building, as an indication to the fire severity.

Table 19 Extent of Flame Damage in Hospitality Industry

Extent of Flame	Incident #	%	Casualty #	%	Fatality #	%
0 Unknown	2320	63.5	70	35.7	3	11.5
1 No damage of this type	99	2.7	3	1.5	0	0
2 Confined to object of origin	252	6.9	3	1.5	0	0
3 Confined to part of room or area of origin	450	12.3	22	11.2	0	0
4 Confined to room of origin	180	4.9	7	3.6	0	0
5 Confined to fire cell of origin	43	1.2	8	4.1	2	7.7
6 Confined to floor of origin	51	1.4	8	4.1	3	11.5
7 Confined to structure or origin	229	6.3	71	36.2	18	69.2
8 Extended beyond structure of origin	27	0.7	4	2.0	0	0
9 Unable to classify	1	0.03	0	0.0	0	0
Total	3652		196		26	

Table 20 Hospitality Industry Incident Fire Type

Types of Fires	Incident #	%	Casualty #	%	Fatality #	%
Unknown Fire	2321	63.6	70	35.7	3	11.5
Smouldering Fire	351	9.6	6	3.1	0	0
Non-Flashover Fire	630	17.3	29	14.8	0	0
Flashover Fire	350	9.6	91	46.4	23	88.5
Total	3652		196		26	

It is shown in the above Tables (Table 18 & Table 19 & Table 20) that almost all of the fatalities along with nearly half of the casualties, which occurred in the hospitality industry, were associated with flashover fires. The percentage of flashover fire was not that great, only 9.6% of total incidents happening. However, when they did occur, they would be the most catastrophic types of fire. More research would have to be done in order to find out the characteristic and cause of each flashover fires.

5.3.10 Hospitality Fires Object Ignited

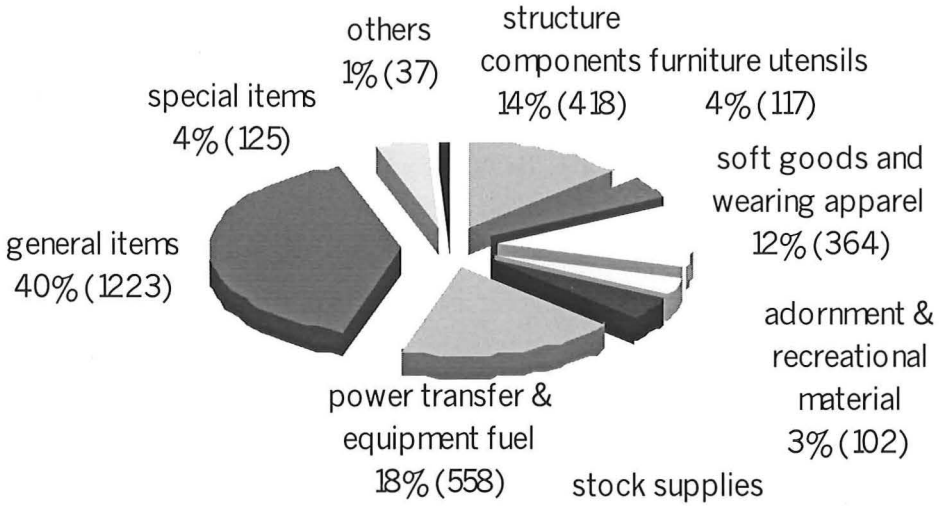

Figure 35 Hospitality Fires Ingited Objects

Figure 35 shows that the biggest group of ignited objects is general items, within the group, cooking material/food stands for the biggest proportion, followed by rubbish/garbage/waste. This reflects to the fact that restaurant fires stand for the highest portion of all hospitality incidents.

6 CASUALTY FIRE EXPERIENCE & TRENDS

6.1 Hospitality Fatal Fire Incidents and Trends

Now, it is time to concentrate on the fire incidents with fatalities within the hospitality industry:

It is to be noted that since there were only 12 fatal fire incidents and 26 fatalities in total, it is not sufficient for any strong conclusions to be drawn. The results in this section of the report could only be used as an indication.

6.1.1 Incident Time

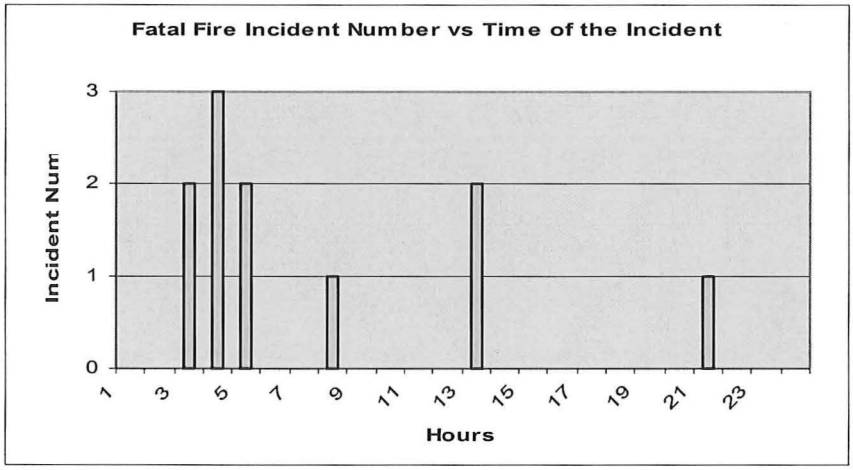

Figure 36 Fatality Fire Incidents Happened hour

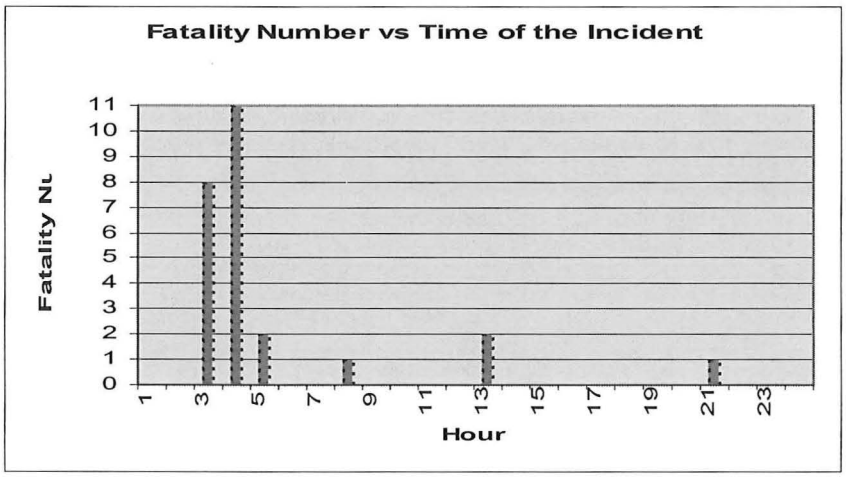

Figure 37 Fatality Number with hour

In the past 15 years, there were 12 fire incidents with fatalities. It is shown in Figure 36 that almost all of the fire incidents happened around the normal sleeping hours (22~8). Only 3 incidents out of the 12 happened during daytime. Among the 12 fatal fire incidents, there were 26 occupants killed, some of them happened in the same incident. The worst one was at 4:00 am on 20 November 1992, with seven occupants killed in total. The second worst one happened at 3:00 am on 4 February in 1995, six people killed in total. The plotted incident time trend shows at night-time when occupants were asleep, it is the most dangerous time for fire incidents to occur. It is due to the fact that most of the occupants were still asleep and they need more time to wake up from deep sleep, and start to react to the situation.

6.1.2 Incident Type

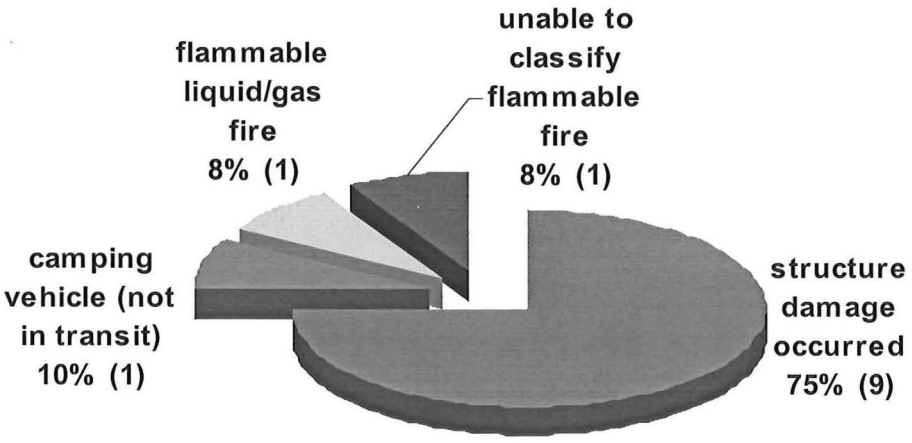

Figure 38 Fatal Fire Incidents' Incident Type

Generally the fatal fire incidents that occurred were mostly structure fires with structure damaged (80%). There was one camping vehicle incident, one flammable liquid/gas fire and one unidentifiable flammable fire incident as well. This result is the same as what has been expected, since most incidents occur in the hours of sleep with most fatalities being those still asleep. What killed the occupants was the flame or smoke trapping the occupants inside the structure, therefore the structure fires are what would be expected.

6.1.3 Incident SPUse

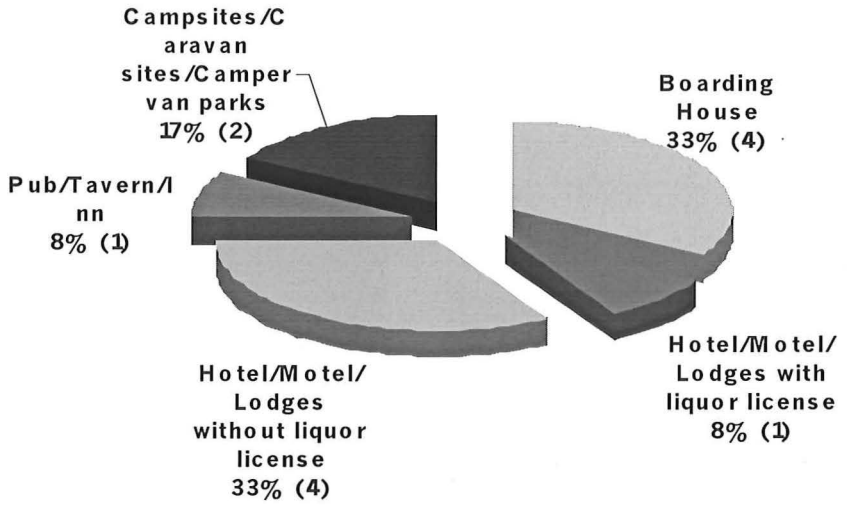

Figure 39 Fatal Fire Incidents' Property Specific Property Use

In the past 15 years, 12 fatal fire incidents have happened, and almost all of them were accommodation type of properties, the distribution is shown in Figure 39. The one with the most fatal fire incident was Boarding house and Hotel/Motel/Lodges category. In order to decrease the fatality number, it is worthwhile to look into the categories and find out the trends inside for further research

6.1.4 Incident Causes

There were 12 different causes for those twelve fatal fire incidents over the past 15 years, and they are listed below:

- 111unlawful
- 114 suspicious
- 211 reckless
- 311 careless disposal
- 313 falling asleep (cooking)
- 316 heat source too close to combustibles
- 399 unable to classify careless with heat sources
- 511 parts failure/leak or break
- 515 other electrical failure
- 712 accidentally turned on and not turn off
- 713 accidentally turned equipment unattended
- 999 unable to classify other supposed cause

There is no special trend for the cause of fatality fire incidents since every single fatality fire had a different cause.

6.1.5 Locations of Fatal Hospitality Fire Incidents' Fire Origin

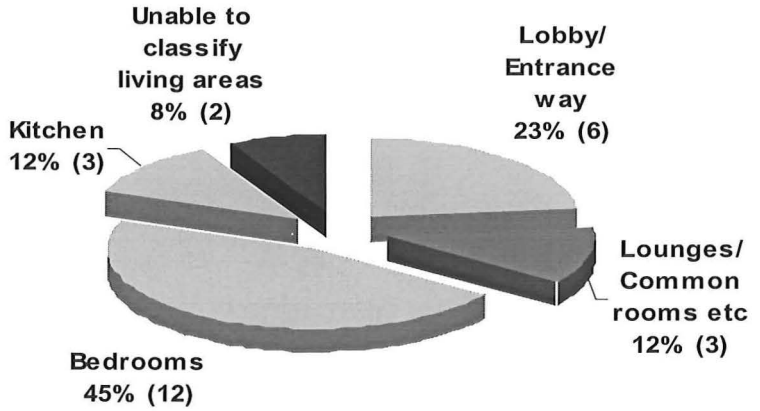

Figure 40 Location of Fatality Fire origin Distribution

It is shown in Figure 40 that not only did most of the fatalities happen in the bedroom area, but most of the fire also originated in the bedroom area. As in Figure 51, although most fire origin were in the bedroom area, it does not have a direct connection with the fatality since most of the fatalities were not inside the room of origin when the incident happened (Figure 51).

6.1.6 Incident Heat Sources

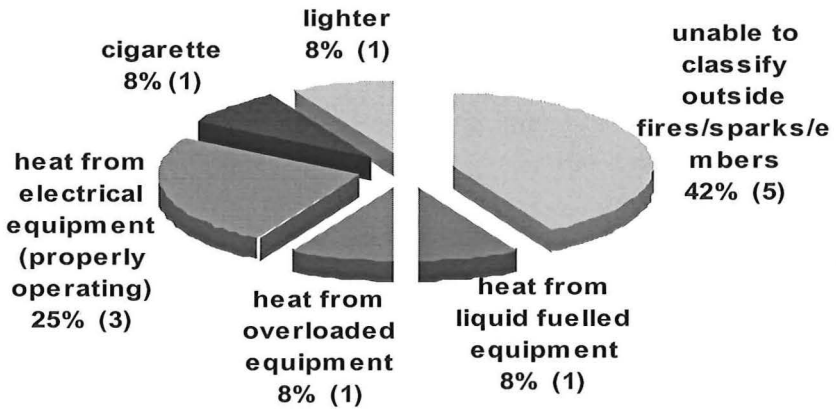

Figure 41 Fatal Fire Incidents' Heat Sources

Heat sources for the 12 fatal fire incidents were distributed as shown in the pie graph above (Figure 41). The highest heat source percentage was the "unable to classify outside fires/sparks/embers".

6.1.7 Ignited Objects

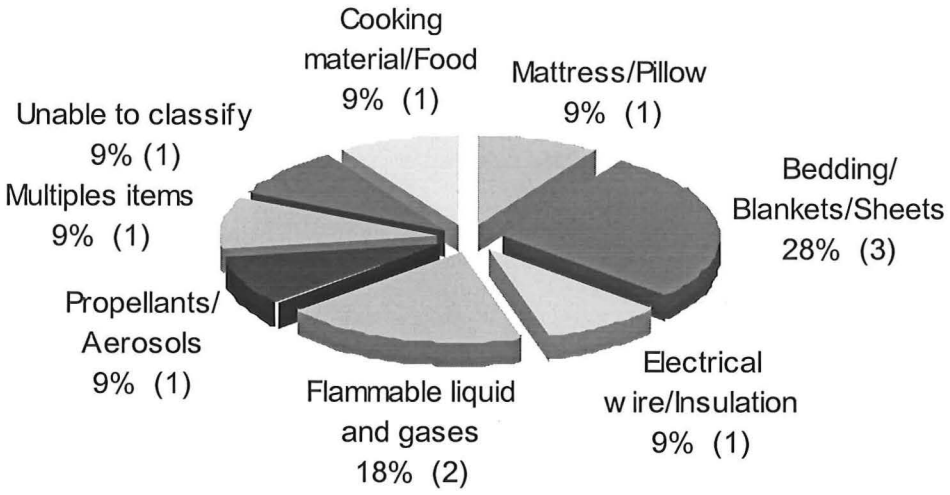

Figure 42 Distribution of objects ignited in fatal incidents

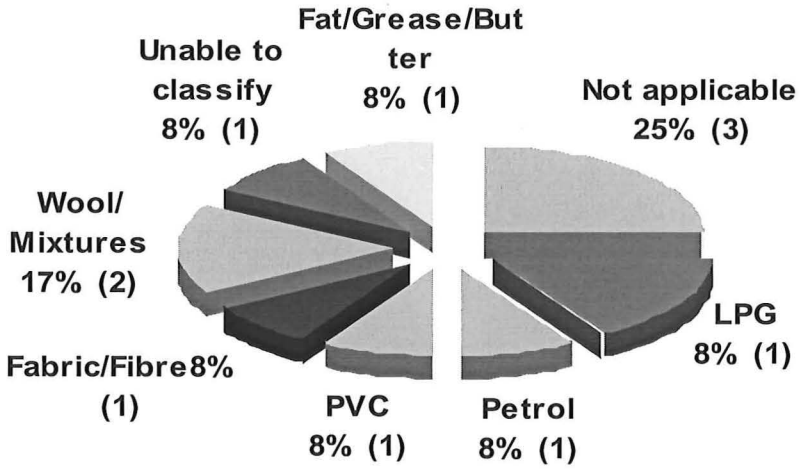

Figure 43 Distribution of Ignited object material in fatal incidents

Figure 42 & Figure 43 show that among the 12 fatal fire incidents, there were 8 different ignited objects, including the unable to classify ones. As mentioned before, most fatalities happened at night-time when occupants were still in bed. Therefore ignited objects were mostly related to that as well. For example, Mattress etc and the main material were fibres. For details please refer to Appendix B.

6.1.8 Building Area

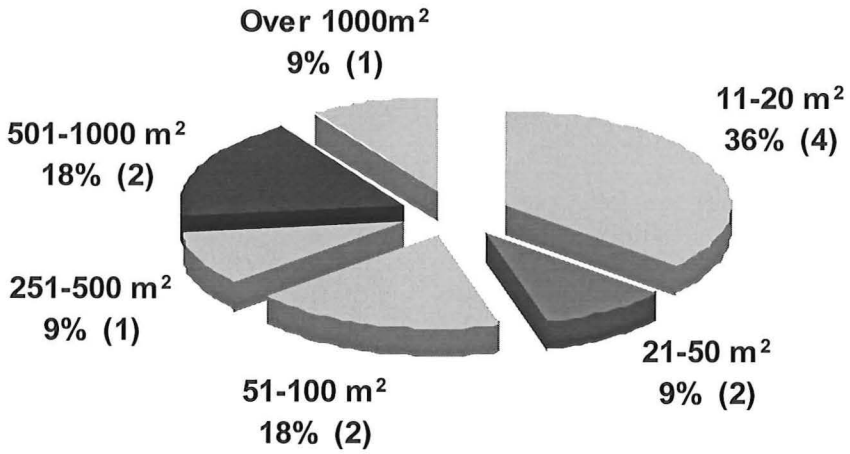

Figure 44 Fatal Incidents' Building Area distribution

It is shown in the above Figure 44 that building areas varied from 11~20m^2 to over 1000 m^2. It seems like there are no special trends or relationship between the building area and the fatality incident number, or the fatality number itself.

6.1.9 Construction Type

As one would probably expect, 9 of the 12 fatal fire incidents were ordinary housing with unprotected timber frames. It is suspected to be the most common and widely used construction material within New Zealand., but further research is required on this. If it is so, then it might explain why so many fire incidents fall into this construction type.

Refer back to section 5.3.5, there were only 43% of the total hospitality fire incidents happened within properties constructed by unprotected timber frame. As mentioned before, 70% of the hospitality fatal incidents happened in this particular type of construction, there seemed to be a bit outweighed but further research was needed for proof.

6.1.10 Material Generating Most Flame/Smoke

Not surprisingly, since the most popular construction type is timber frame, the material that generated most flame and smoke for the 12 fatal fire incidents was Sawn-wood which includes all finished timber. Sometimes there were multiple materials ignited, which might cause a large amount of flame and smoke.

6.1.11 Fatality Occupants

More details of the trends within the fatalities were researched to see whether there were any specific common characteristics of the fire incident fatalities.

Occupant Age

From the 12 fatality fire incidents, which happened during the past 15 years, the fatalities were usually within the same age group for each single fire incident. Moreover the occupant age is suspected to be relevant to the specific use of the property. Eg for the following three multi fatality incidents, the occupants' ages are listed below:

- Boarding House, generally all young people – 16,17,13,21,22,17 and 20.
- Hotel/Motel/Lodges without liquor licence, generally older people in this kind of incident – 35,95,95,19,71 and 75.
- Hotel/Motel/Lodges without liquor license, generally young children in this kind of incident– 6,4 and 10.

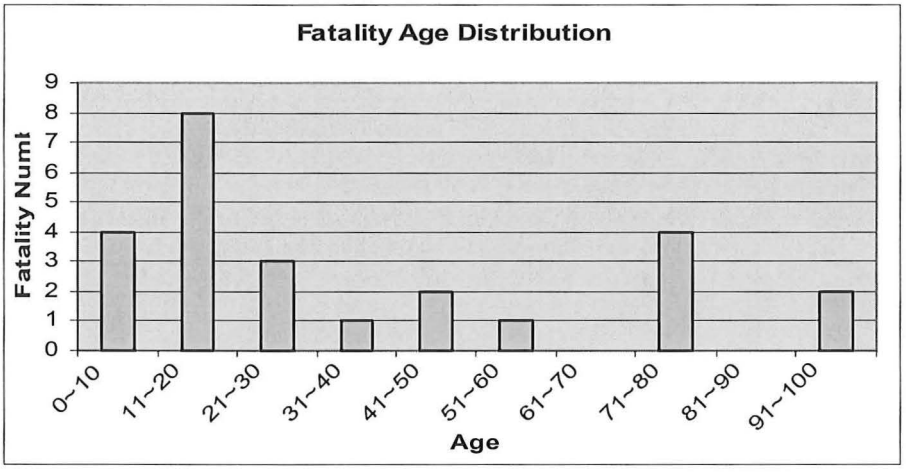

Figure 45 Hospitality Fire Incident fatality Age Distribution(for the 12 fatal fire incidents)

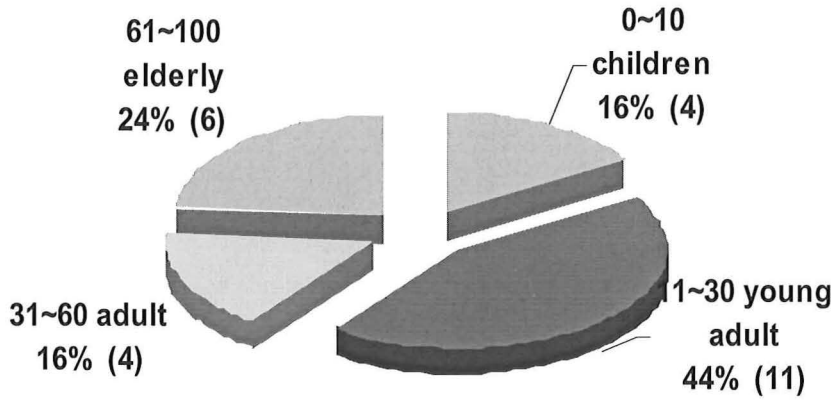

Figure 46 Hospitality Fire Incident Fatality Age Distribution

Note: the age group in Figure 46 is classified under the author's own definition, so that it is easier on the reader.

It is shown in Figure 45 that mainly the young and very old are in higher fire risk, since as a proportion to the nation's population the fatalities stand for a higher percentage. But further research might be required on the exact population for each of the age group and therefore an accurate risk index could be calculated. Human evacuation capability depends on many aspects, age is one among the many, and one possible explanation is that the young might not understand the danger of fire or the very old would not be capable of getting out due to their physical limitations.

Occupant Familiarity

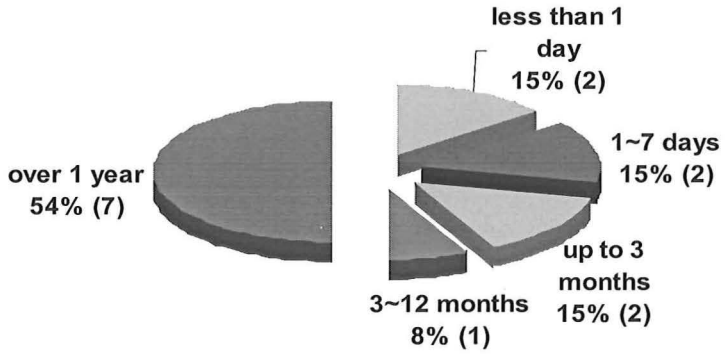

Figure 47 Hospitality Fire Incident Fatality Familiarity Distribution

Among the 26 fatalities, there were only 14 familiarity reports. Although the coverage is quite low, there could still give some indication. Figure 47 shows that, surprisingly, more than a half of the reported fatalities had more than one year of familiarity with the incident property. Most readers would probably expect that fatality would have a pretty low familiarity with the property, therefore they did not know their way around the building and not being able to escape the incident alive. But obviously this expectation is not 100% correct according to the given data.

Cause of fatality

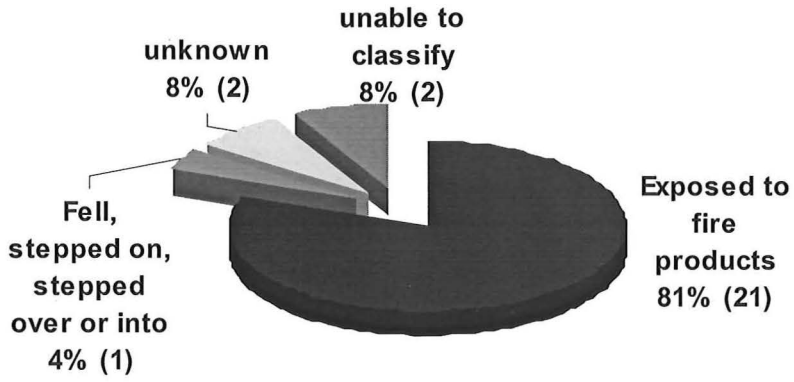

Figure 48 Hospitality Fire Incidents Fatality's Cause of death

Data based on the cause of injury in database.

Figure 48 shows that as one would expect most of the fatality cause is being exposed to fire products, mostly smoke inhalation or asphyxiation. It is also the highest cause of fatality in any fire incidents statistically.

Activities of injury

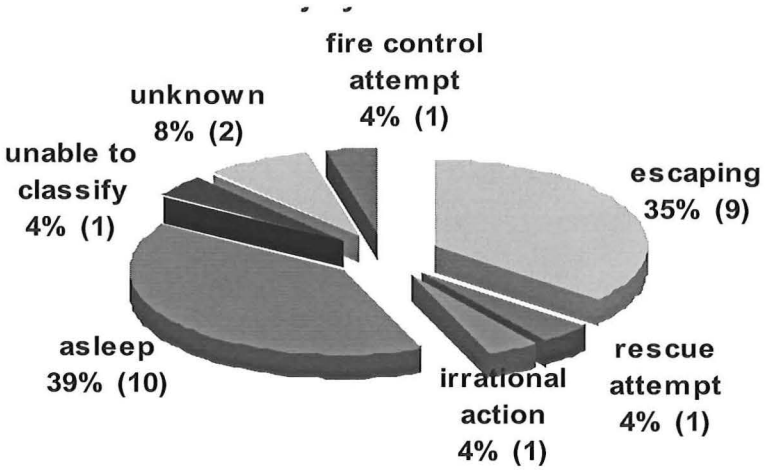

Figure 49 Hospitality Fire Incident Falality's activity when injured

Not surprisingly, most of the activity of those suffering fatality when killed were sleeping or escaping. It is shown in Figure 36 that most of the fire fatalities happened in the early morning at around 3:00 am – 5:00 am when it is still dark and occupants were still sleeping. Even though some of the occupants were awake and attempted to escape, the dark and smoky conditions would not allow them to come out safely. Therefore it could be concluded that night-time fire incidents are more dangerous in consideration of life safety.

Condition of Fatality before Injury

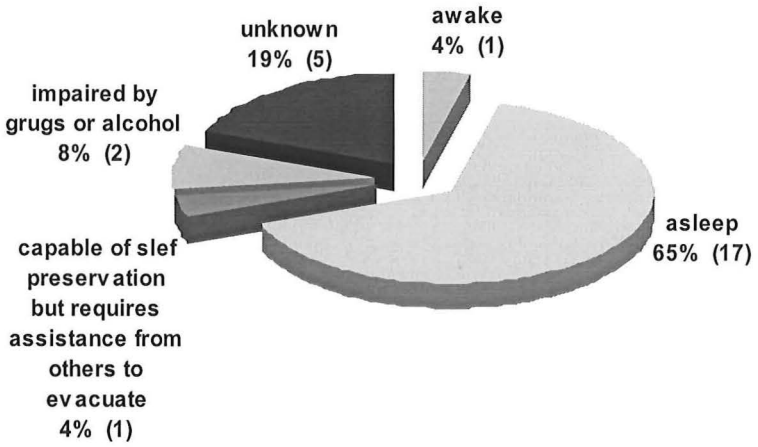

Figure 50 Fatality condition before injury

As mentioned in the previous section, most of the occupants' conditions were being asleep due to the fact that a lot of the incidents happened in the early morning when ordinary people were still in bed. There were 2 young occupants impaired by drugs or alcohol before the incident, and one of them even required assistance to escape. The only one that was awake and should have had more chance of surviving died of asphyxiation when escaping. Although it is not very clear in the limited data given, there are other sources [1] show that a lot of fatalities were impaired by drugs or alcohol, and sometimes it might not be the victim who was impaired. Eg. parents maybe impaired by alcohol and fail to react fast enough to save the children.

Location of Fatality at Ignition Time

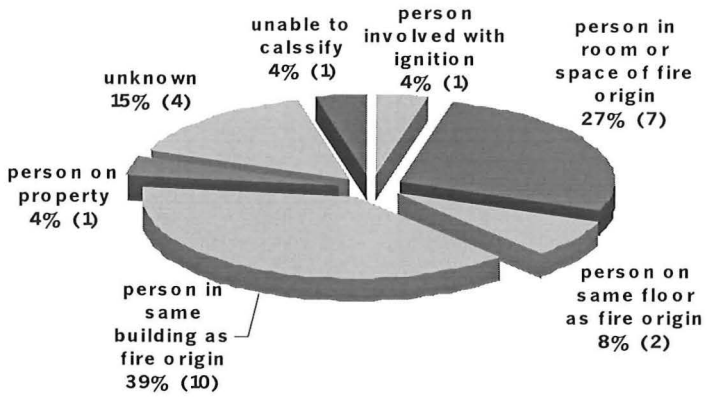

Figure 51 Hospitality Fatality Occupant's Location at Ignition Distribution

Figure 51 shows that most fatalities were in the same building as the fire origin. It would be obvious to expect so since most incidents were structure fire. But occupants were not necessarily on the same floor or even in the same room or space as the fire origin. These findings show that most of the occupants might not even have been aware of the fire or seen the fire themselves since a high percentage of the fatalities were still asleep when the fire occurred.

Factors Preventing Escape

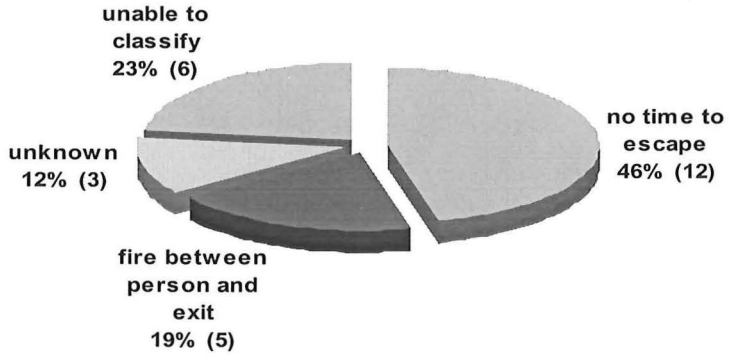

Figure 52 Factors preventing fatalities from escape

Continuing from the discussions above, the factor that kept most occupants from getting out safely was the limited time available. Since most occupants were still asleep, most of them could not react quickly to the emergency when the incident happened. Some of them might never have wakened.

6.2 Hospitality Injury Fire Incidents and Trends

If one just concentrates on the fire incidents with injury alone:

6.2.1 Incident Time

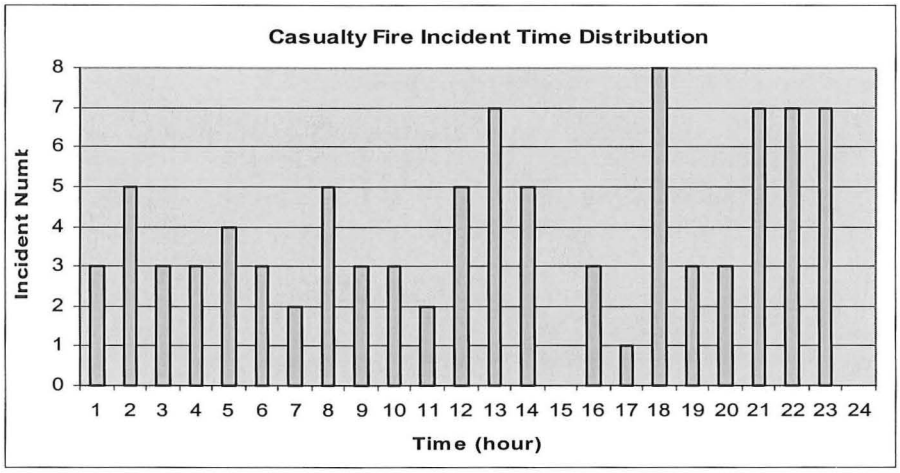

Figure 53 Injury Fire Incidents' Time Distribution

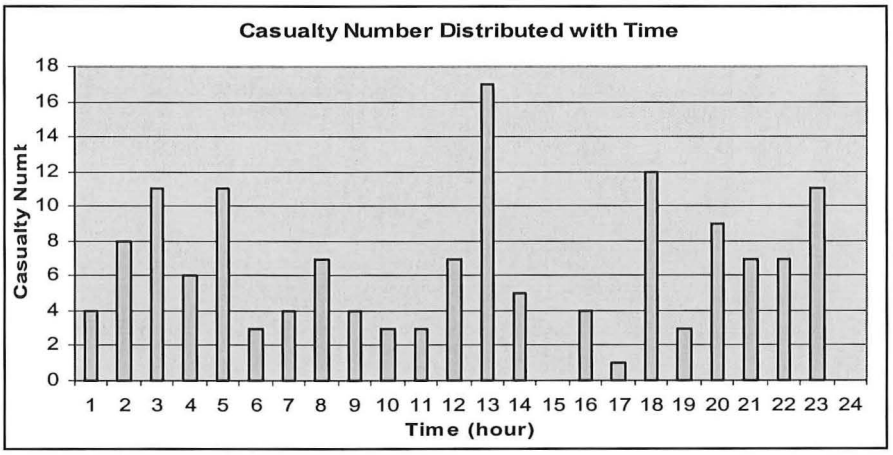

Figure 54 Injury number Time Distribution

In the past 15 years, there was 116 Injury fires in total (excluding fatalities). There was no special trend in the times, during which the incidents happened for the injury fires, since injury fire incidents happened in each time frame. However, it seems like the time between 21~23 hours are a highly risky time for injury fire incidents to happen. For Figure 54, some of the injury might actually have happened at the same fire incident. The worst injury fire incident during the past 15 years happened at 1:00 p.m. 1 February 1998, with 8 injuries, but no fatality.

6.2.2 Incident Type

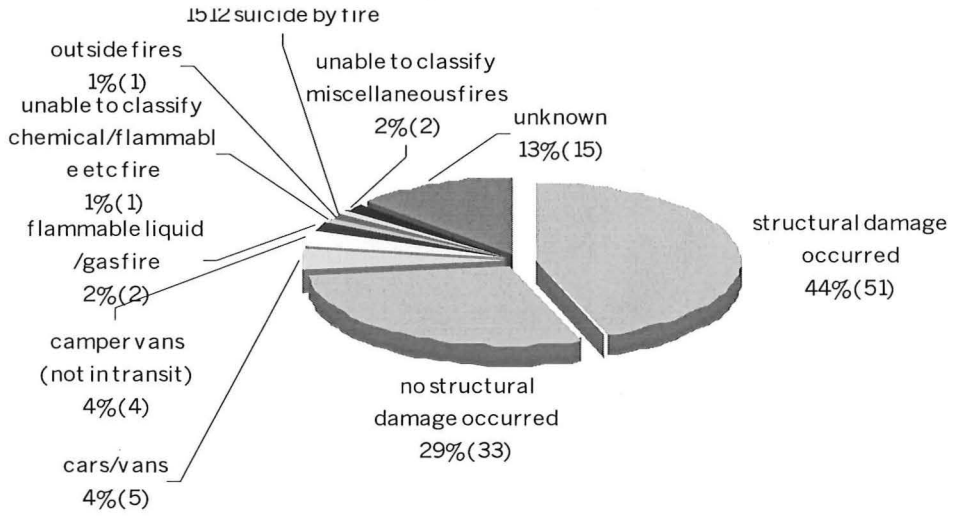

Figure 55 Injury Incident Type Distribution

Figure 55 shows that of all the other fire incidents (mentioned in the previous sections of this paper), the most common incident type is structure fire either with or without structural damage.

6.2.3 Incident Property Categories

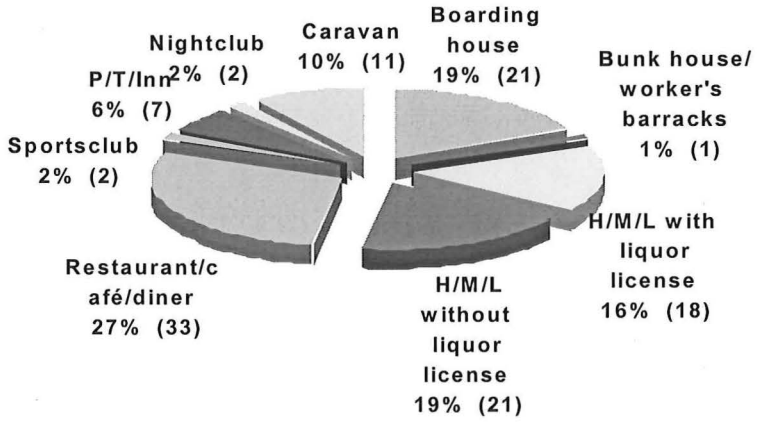

Figure 56 Categories of Injury Fire Incidents

Injury fire incidents can be distributed into the small categories within the hospitality industry, Figure 56 shows the distribution, which is almost the same as Figure 30 except excluding the fatality fire incidents. Among all the categories, restaurants stand for the most injury fire incidents but no fatality occurred within this category. For more details on restaurant fires please refer back to section 8.

6.2.4 Incident Causes

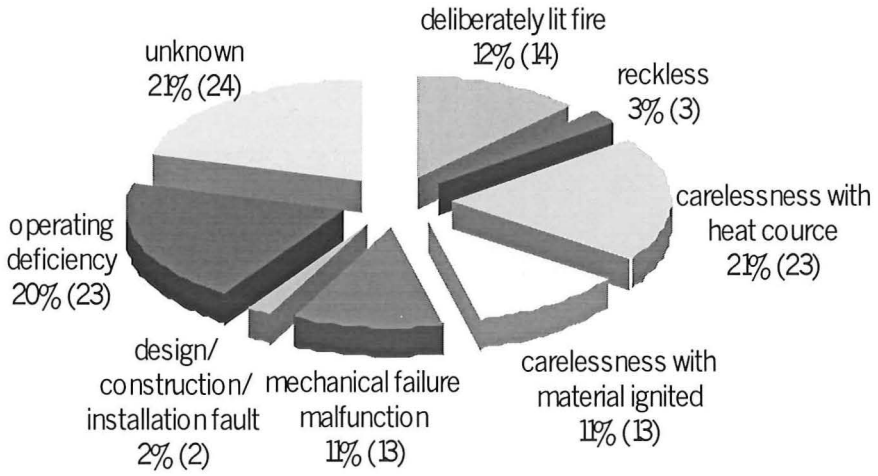

Figure 57 Supposed Injury Fire Causes

Figure 57 shows the percentage distribution of the supposed causes of injury fire incidents, the highest fire cause is carelessness with heat source and operating deficiency as a group. Looking in more detail with the method discussed in section 3.4, the single cause of incident with the highest percentage is unattended equipment.

6.2.5 Location of Fire Origin (Incidents with injuries)

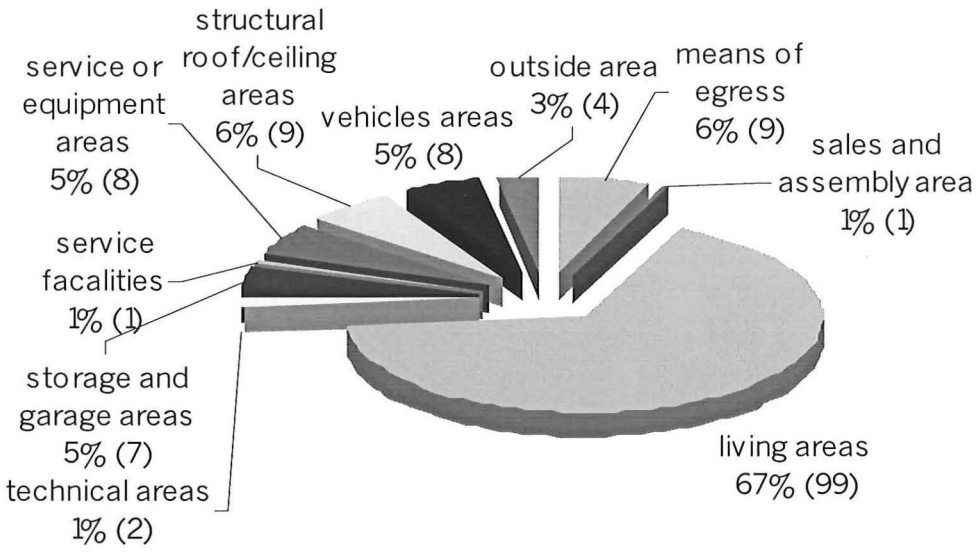

Figure 58 Fire origin for Incidents with injury

Figure 58 shows that most fire origins for incidents with injury happened in the living areas, including lounges, bedrooms, dining areas, kitchen, and laundry areas etc. Among all the living room originated fire, kitchen/cooking areas have the highest proportion rather than bedroom area (Figure 40). This is due to the fact that a larger proportion of fire incidents happened in food providing occupancy such as restaurants rather than accommodation type categories. Therefore in some cases there was no bedroom existing on the property at all, which certainly lowered the possibility of fire origin in the bedroom areas.

6.2.6 Incident Heat Sources

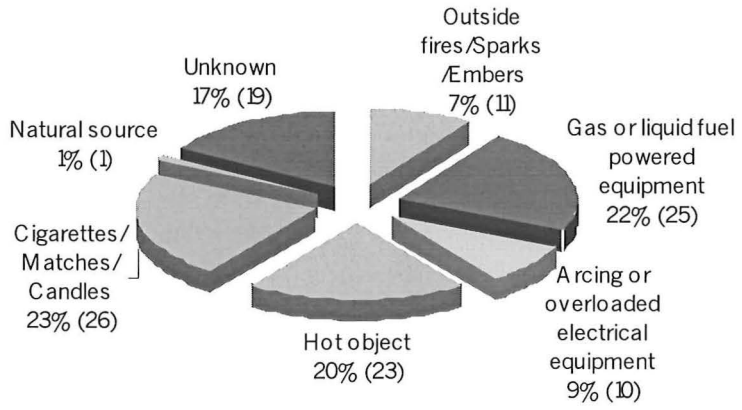

Figure 59 Injury Fire Heat Sources

The heat sources for the 115 injury fire incidents are distributed as above. Cigarettes/matches/candles stands for the highest percentage among all the others, which is obviously a careless action.

6.2.7 Ignited Objects

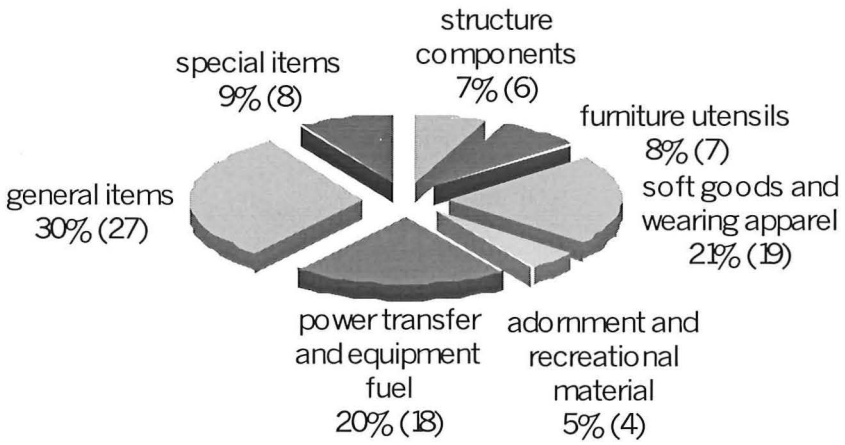

Figure 60 Ignited Objects

Figure 60 shows that there is no special trend for the ignited objects. However, soft goods, general items and power transfer all have a high proportion of material, which was easily ignited. Not surprisingly, cooking material/food has the highest percentage as the ignited object since kitchens (living area) are the most common place for injury fires to occur (Figure 58).

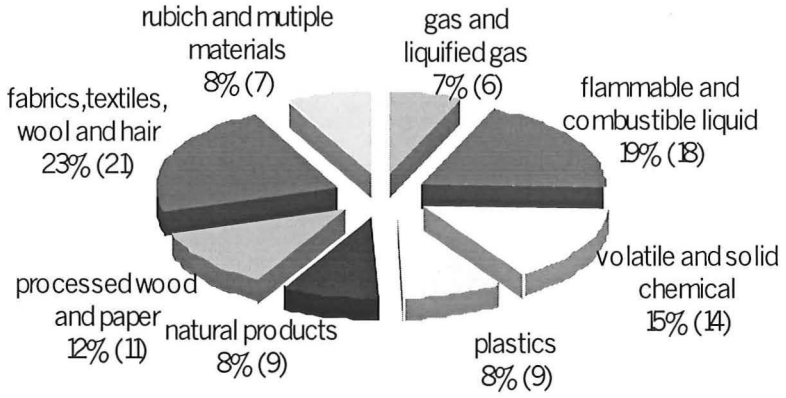

Figure 61 Ignited Object Material

Figure 61 shows that instead of fat or other possible kitchen/cooking materials, the one having the highest percentage as the material of ignited objects were fabric. It is quite strange, and this might be due to the fact that objects in all kinds of areas might consist of fabric, as the material was not limited to a certain place.

6.2.8 Building Areas

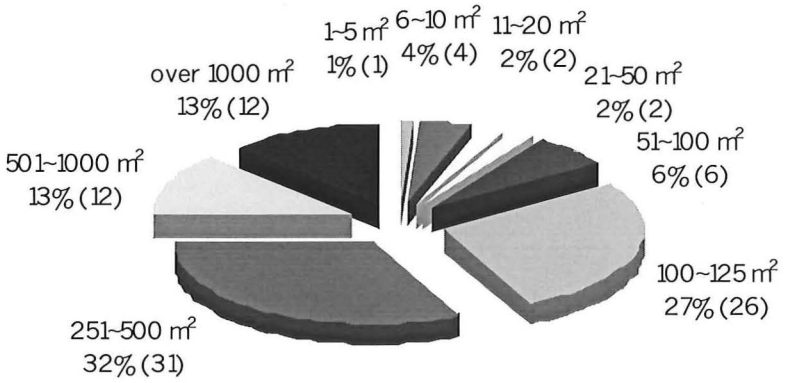

Figure 62 Incidents with injury building area distribution

It is shown in Figure 62 that more than half of the injury incidents occurred in buildings with an area more than 250 m^2. It is quite a large space, far greater than normal residential houses. So far, there is not enough evidence to say there is any relationship between the area and incident number or injury number.

6.2.9 Construction Type

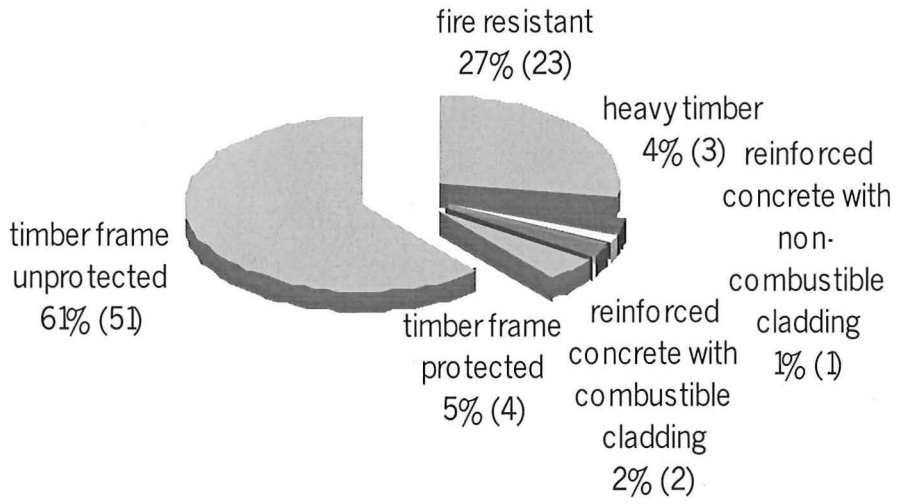

Figure 63 Incident with injury's construction type

It is shown in Figure 63 that most of the incidents with injury occurred in properties constructed of unprotected timber frame, and it was the same as most of the fatal incident constructions.

6.2.10 Material Generating Most Flame/Smoke

As discussed in the previous section (section 6.1.10), the material that generates most flame and smoke is sawn due to the fact that most buildings are constructed of unprotected timber.

6.2.11 Injured Occupants

Note: Some excluding unknown occupants

Occupant Age

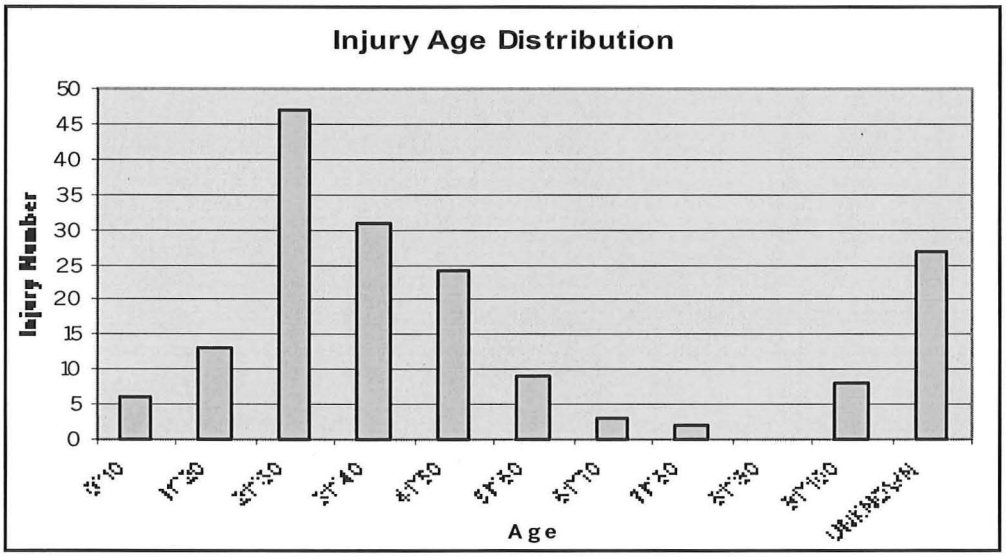

Figure 64 Hospitality Fire Incident Injury Age Distribution

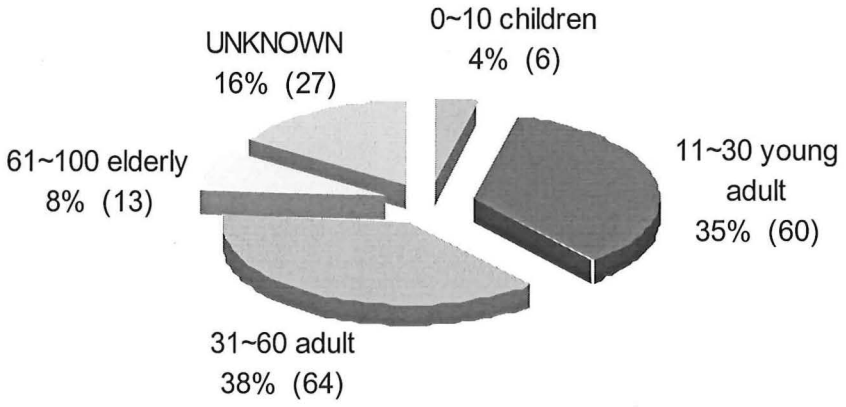

Figure 65 Injured Occupant Age Distribution

It is shown in the above Figure 65 that the highest percentage of injured occupants were adults rather than children or elderly people. The age group with highest injury was aged 20~30.

Occupant Familiarity

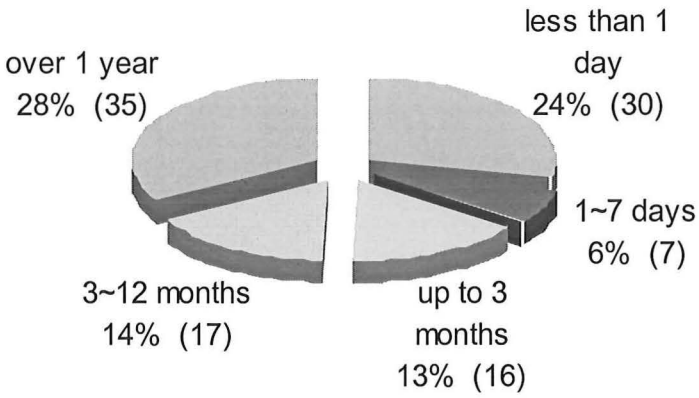

Figure 66 Injured Occupant Familiarity Report

Figure 66 shows that quite surprisingly 28% of the occupants were quite familiar with the surroundings. Compared to the fatalities, occupants' familiarity with the building is certainly reduced. This also shows that familiarity might not be as important as one would expect, but this might also be due to the misleading limited data available.

Cause of Injury

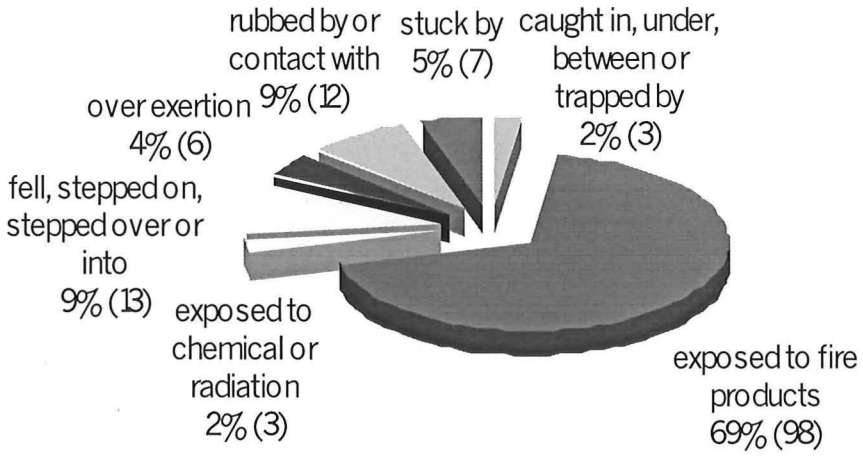

Figure 67 Causes of Injury

It is shown in Figure 67 that up to 69% of the occupants were injured from exposure to fire products, and this was also the highest cause of fatality.

Activities of injury

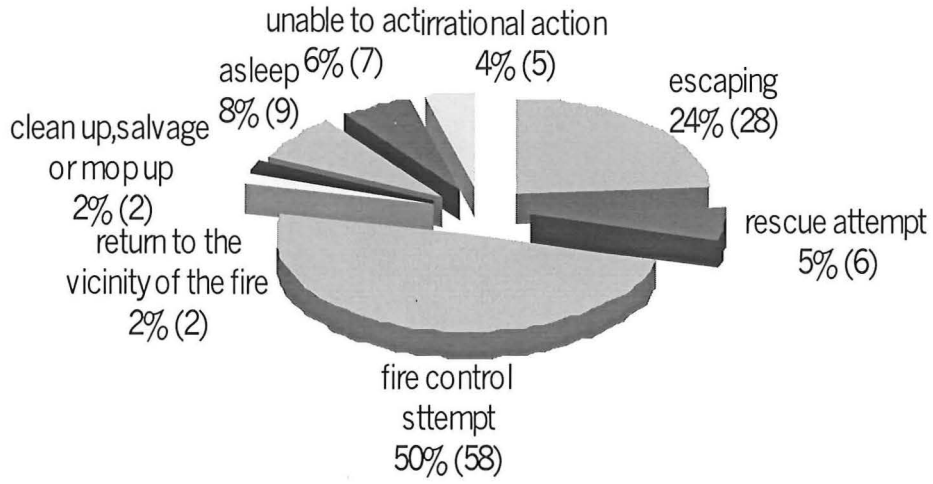

Figure 68 Activities of Injuries

It is shown in the above Figure 68 that half of the injured occupants attempted to fight the fire rather than escape straight away. This also relates to what has been discussed in the previous section. (Figure 65) Most of the injured occupants were adults who are capable of fighting fires. This finding shows the need to educate the public concerning the accurate methods of fire fighting, and inform them of the need to call the fire brigade rather than attempting fire control. This is so that the raising of the alarm would not be delayed by occupants taking valuable time to investigate or try to fight the fire before calling the fire department.

Condition of Occupants before Injury

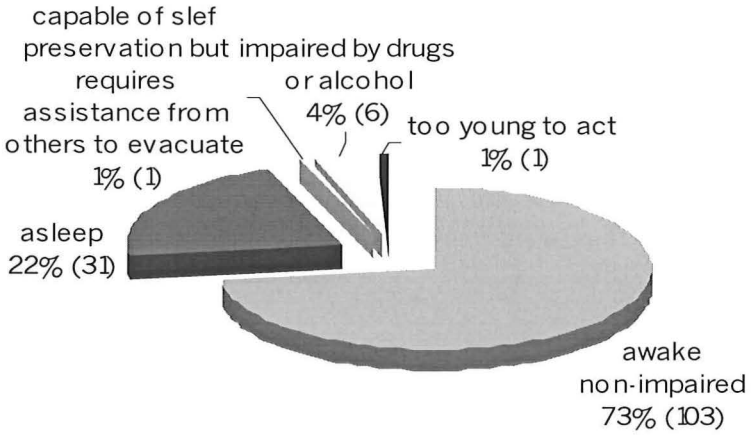

Figure 69 Conditions of Injured Occupants before injury

In contrast to the fatalities, Figure 69 shows that most of injured occupants were awake and non-impaired rather than asleep, which is why the occupants were aware of the incident at an earlier time and had more chance of getting out with just injuries.

Location of Injured Occupants at Ignition Time

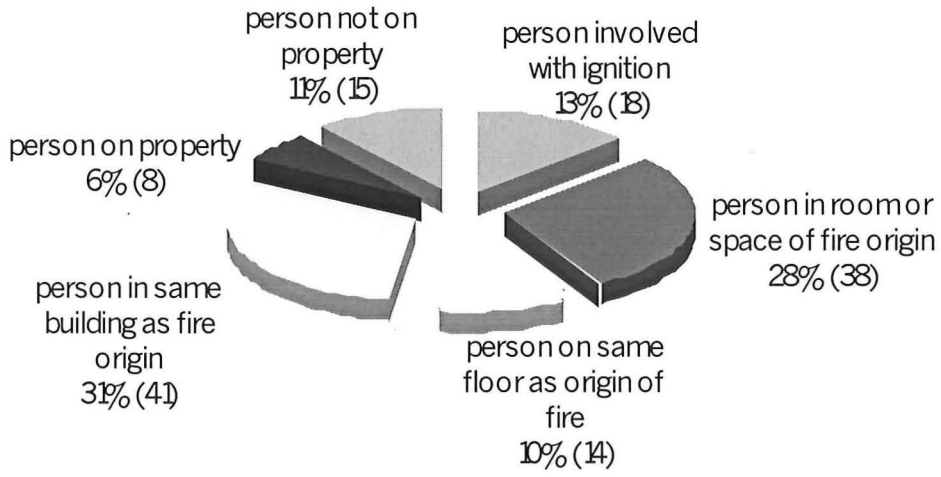

Figure 70 Location of Injured Occupants at time of ignition

It is shown in Figure 70 that occupants injured in fire incidents, were not necessarily in the same space or even on the same floor as where the fire started. However, the occupants in the rooms or space of fire origin had a slightly higher chance of getting hurt than others, due to the fact they were directly exposed to fire products.

Factors Preventing Escape

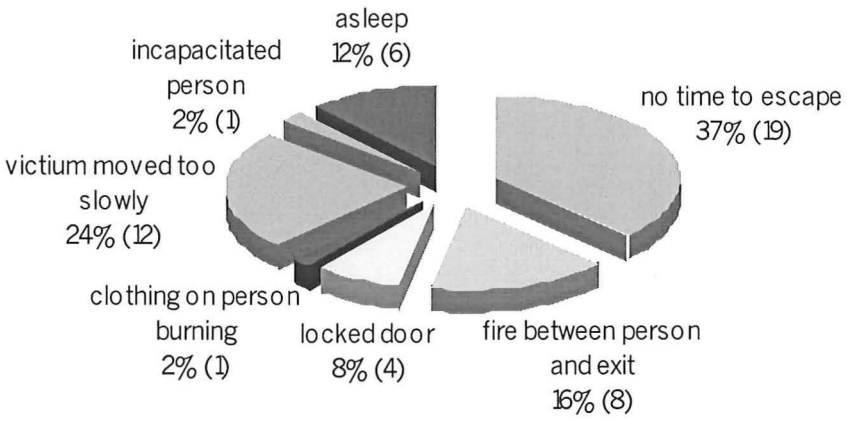

Figure 71 factors preventing injured from escape

Compared to factors preventing fatalities from escaping, the most common factors preventing injured occupants from escaping are still the time allowed (Figure 71). However, there are some other factors e.g. clothes on fire; which did occur occasionally but no one was killed from that. This is a bit different from fatal fire incidents since occupants were awake and free to get out. However, most of them chose to stay and fight the fire, but got injured from such an action.

7 Comparisons Between Injury and Fatal Fire Incidents

Table 21 Comparison between Injuring/Fatal/Overall Fire Incidents

	Fatal Incidents/Fatalities	Injuring Incident/Injuries	All Incidents
Time	Late night or early morning	-	-
Incident Causes	-	Carelessness (32%)	Mechanical failure malfunction (20%)
Heat Source	Heat from electrical equipment (25%)	Heat from gas fuelled equipment (15%)	Heat from electrical equipment (13%)
Fire Origin	Bedrooms (45%)	Kitchen (28%)	Kitchen (24%)
Object Ignited	Bedding/blankets (28%)	Cooking material/food (13%)	Cooking material/Food (15%)
Activity of Injury	Asleep (39%)	Fire control attempt (50%)	-
Condition Before	Asleep (65%)	Awake non-impaired (73%)	-
Occupant Age	11~20 (31%)	21~30 (28%)	-
Familiarity	Over 1 year (54%)	Over 1 year (28%)	-
Occupant Location	In same building (39%)	In same building (31%)	-
Cause of death/injury	Exposed to fire products (81%)	Exposed to fire products (69%)	-
Construction Type	Unprotected timber frame (75%)	Unprotected timber frame (61%)	Unprotected timber frame (25%)
MM Flame/Smoke	Sawn	Sawn	Sawn
Incident Type	Structural fires	Structural fires	Structural fires
Fire Type	Flashover fires (100%)	Flashover fires (72%)	Non-Flashover fires (17%)

- Indicates no special trends or not applicable.

It is shown in Table 21 that there are some special trends and differences between those three categories, which are fatal, injury and all fire incidents:

Most of the fatal fire incidents happened at night or early in the morning when occupants were still asleep. Most fires were originated from bedrooms with heat sources from electrical equipment, which ignited mostly bedding materials. Most fire incidents with injury do not

have any time trends, but mostly were due to careless actions. Heat sources for most incidents with injury were from gas fuelled equipment and mostly originated from kitchens with cooking material/food being ignited. For all hospitality fire incidents there were no special time trends. The highest percentage of incident cause was mechanical failure malfunction with the highest cause being heat source from electrical equipment. As with incidents with injuries, most of the fire origins are in the kitchen area with cooking materials being first ignited because the largest proportion of fire incidents were food providing categories such as restaurants.

As to the characteristics of the casualties, one interesting fact to be noticed is that most fatalities were still asleep at the time of ignition, but most injured occupants were awake and non-impaired. Most of them got hurt because they were trying to control the fire. Both fatalities and injured occupants' familiarity were mostly quite high (over one year), which was different from what might have been expected. Generally one would expect that because occupants were unfamiliar with the surroundings and did not know their way around the building, this would all delay their time from getting out. But according to the limited data, this is not necessarily true.

The points that the fatal fire incidents and incidents with injury had in common were that all those incidents happened in unprotected timber frame buildings with material that produces the most flame and smoke being sawn. As one might expect, the highest percentage of cause of death or injury is the exposure to fire products. Most of the building could produce a lot of harmful smoke without additional flammable items. Moreover, almost all fatal fire incidents and the incidents with injury came from structural flashover fires, but in terms of the whole hospitality industry, the highest percentage of fire incidents were non-flashover fires, which were not that severe.

8 Restaurant/Café/Diner Fire Experience

From the previous sections (section 5.1) it has been found that restaurant/cafe/diner is the category, which has the most fire incidents and the most fire incident with casualties. Now a detailed analysis will be done just for this category to find some trends. Also restaurant would be used as the shortened designation for Restaurant/Café/Diner category name in this section.

8.1 General Information

8.1.1 Incident Yearly/Monthly Trend

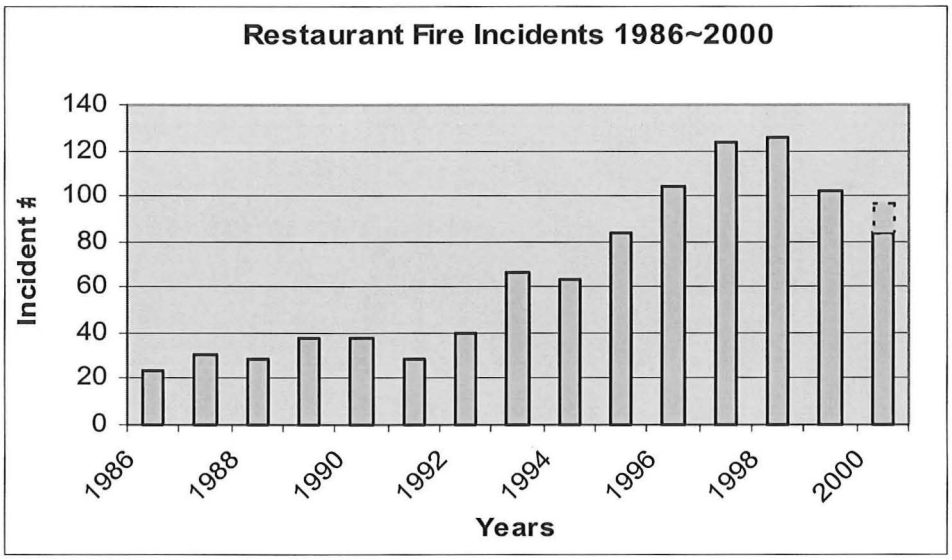

Figure 72 Restaurant Fire Yearly Trend 1986~2000

It is shown in Figure 72 that the restaurant category experienced some changes in terms of yearly fire incident numbers. The incident number started to climb from the years 1992~1993. It then increased constantly every year. In 1998 it reached its peak and then started to fall to its low in 2000. Since the Restaurant category included restaurants, cafeteria and diners, an explanation could be the large increase in café numbers, which led to the increase in incident number since 1993, but the reason for drop of the incident numbers was not at all clear.

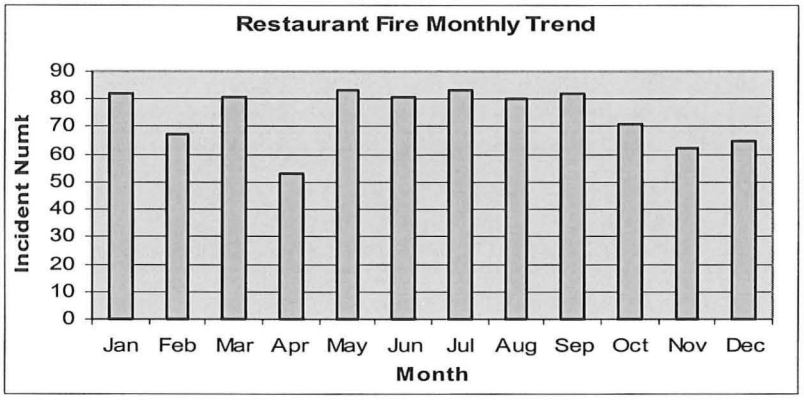

Figure 73 Restaurant Fire Monthly Trend 1986~2000

Figure 73 shows that there was no special trend in terms of incident month for the fire incidents in restaurant category. However, there were some months with low fire incident compared with all the others. Generally April has the least number of fire incidents. This might be due to the fact that it was possibly the low season for restaurant industry, but more research is needed to prove this point.

8.1.2 Restaurant Fire Incidents' Time

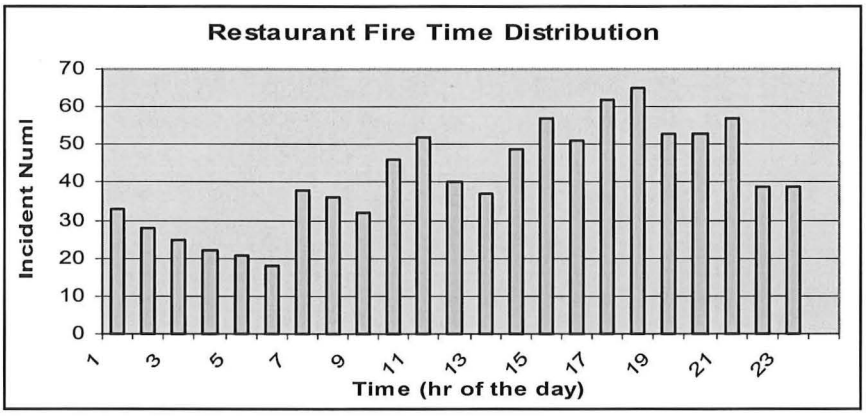

Figure 74 Restaurant Fire Time Distribution

It is shown in Figure 74 that in opposition to the fatal fires, the most likely time for fire to strike is at night-time but not during sleeping hours. The peak time is at 6pm when most restaurants are at their most full, and occupants are preparing to have a meal. There are much fewer fire incidents between midnight until 6am, when most restaurants are likely to be closed. Most incidents occurred in that time frame were due to equipment defaults or arson.

8.1.3 Incident Types

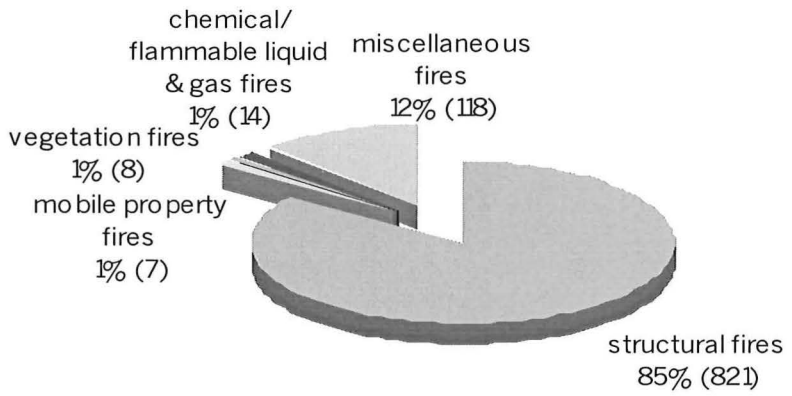

Figure 75 Restaurant Fire Incident Types

It is shown in Figure 75 that like all the other industry/categories, almost all of the fire incidents in the restaurant category were structural fires with or without building damage occurring.

8.1.4 Incident Causes

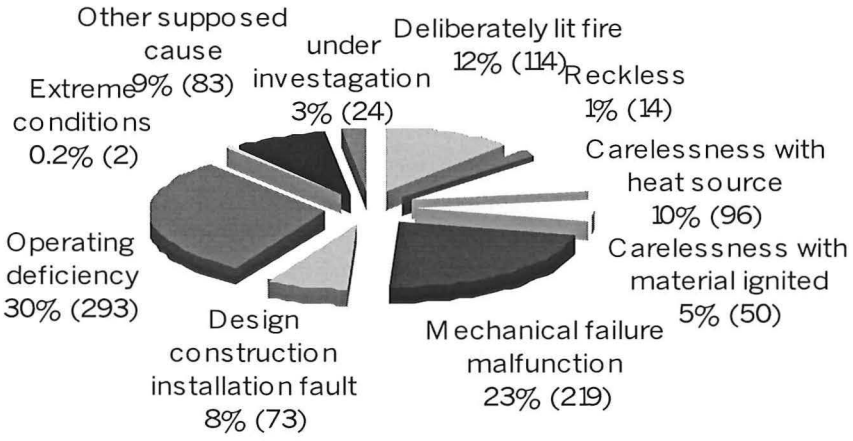

Figure 76 Restaurant Fire Incidents Suppossed Causes

Figure 76 shows that the highest percentage of supposed causes is operating deficiency (30%) followed by mechanical failure (23%), which shows that machinery protection in restaurant is very important, and it might need special fire protection for cooking devices, such as ovens.

8.1.5 Location of Casualty Restaurant Fires' Fire Origin

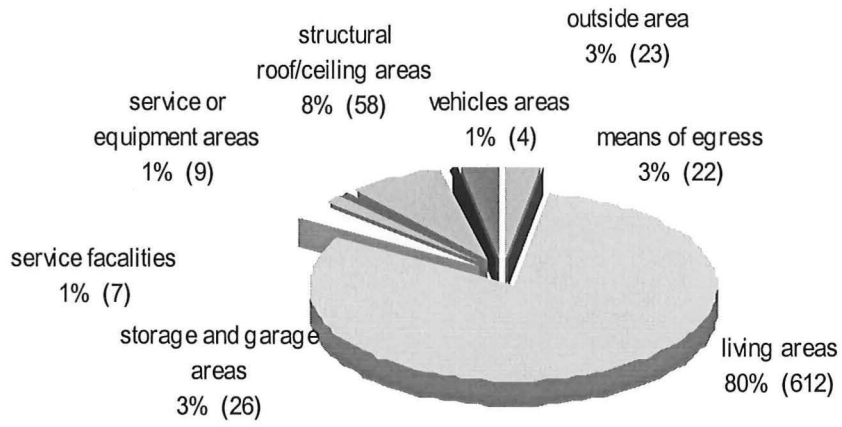

Figure 77 Restaurant Fires' Fire Origin

It is shown in Figure 77 that most of the restaurant fires started from the living area of the building. Among all the living areas, the kitchen stands for the highest proportion as a subset of living areas, as one would probably expect (61.8%), followed by dining areas. Kitchens are the most likely place for fire ignition since they are places with heat sources turned on most of the time especially for a restaurant. There would be times when careless action or unattended food cooking on the stove might happen, even equipment defaults would cause the same level of severe fires. This again addresses the need for special fire protection in this type of category.

8.1.6 Incident Heat Sources

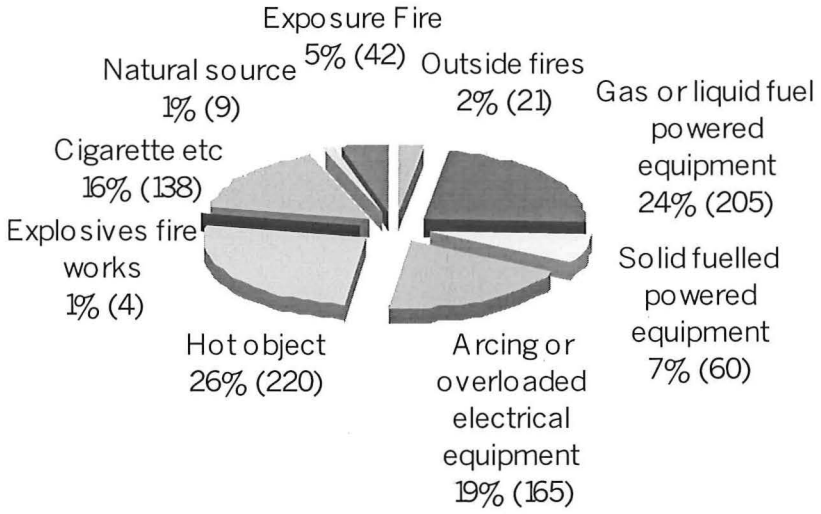

Figure 78 Restaurant Fire Incidents' Heat Sources

Figure 78 shows that the highest proportion of heat sources are hot objects, which could be expected due to the natural environment in the restaurant category. Among all the specific heat sources, heat from gas fuelled equipment and heat from electrical equipment stands for the highest percentage. Together with the supposed causes, it again highlighted the need to protect cooking machines.

8.1.7 Ignited Objects

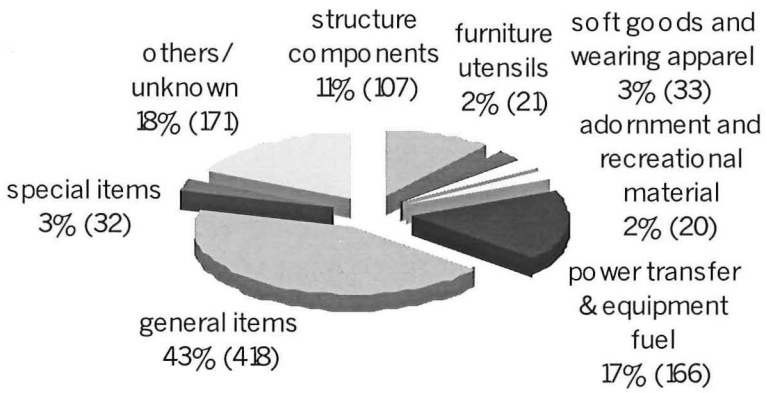

Figure 79 Restaurant Fire Incidents Ingited Objects

It is shown in Figure 79 that almost half of the objects ignited were general objects. Among all the general objects, not surprisingly, cooking material/food (30%) stands for the highest percentage. The next one that had quite a high percentage is the electrical wire insulation (12%). This indicates the need to look at the methods of not only the fire protection but also installation, inspection and maintenance of the cooking device/equipment.

8.1.8 Building Area

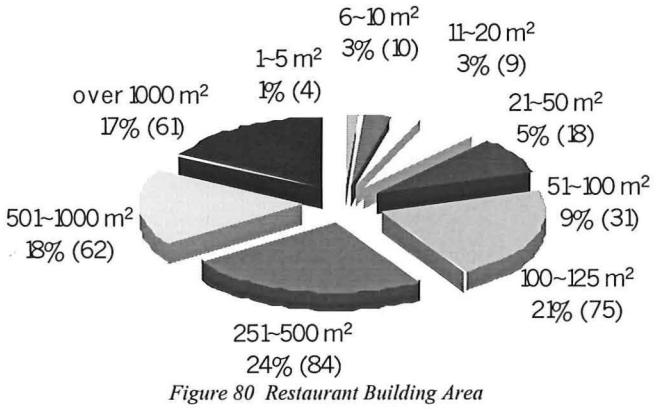

Figure 80 Restaurant Building Area

Figure 80 shows that there is no special trend between the building area and fire incidents. Generally from the given data, fire incidents occurred more often in a building with an area over $100m^2$, which might just be due to the fact that most properties within this category have a building area larger than $100m^2$.

8.1.9 Construction Type

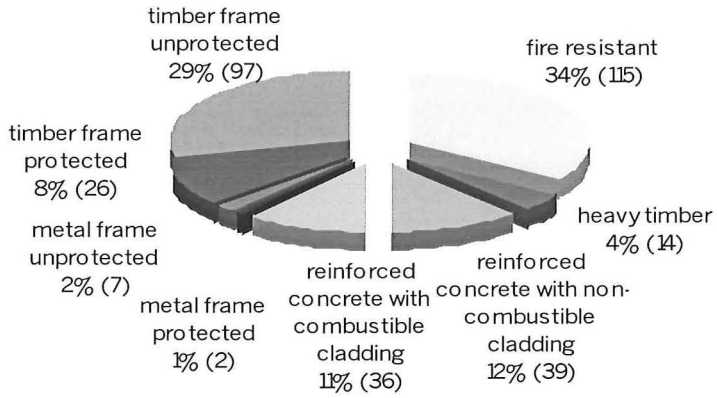

Figure 81 Restaurant with Fire Incidents' Construction Type

Figure 81 shows that there is no special trend within the restaurant construction type and the fire incidents. However, there are some construction types that seem to have more fire incidents than the others. The highest one is fire resistant construction (34%) followed by unprotected timber frame (29%). Further research might be needed to find out whether it is just because there are more establishments constructed by the above two methods.

8.1.10 Material Generating Most Flame/Smoke

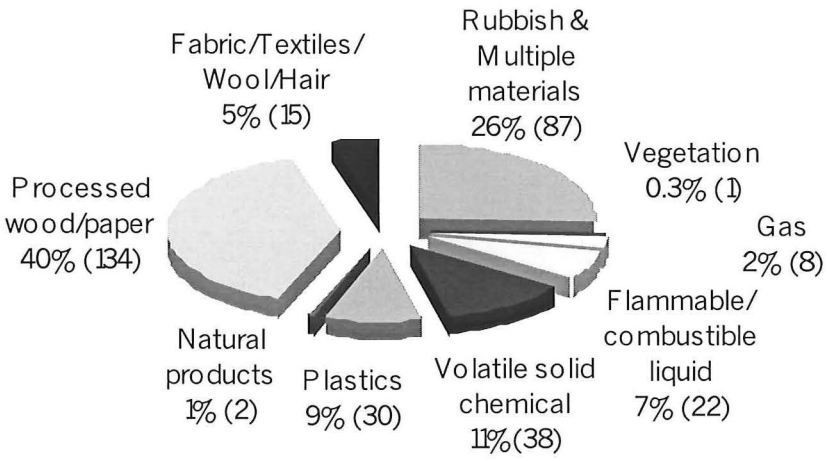

Figure 82 restaurant Fire Incidents' material generating most flame

Figure 82 shows that material generating most flame is processed wood or paper especially sawn (finished wood), followed by rubbish or multiple materials.

8.2 Casualty/Injured Occupants

Looking into the detailed characteristics of occupants, there are only 33 injured occupants reports within the database out of 39 traceable injuries.

Occupant Age

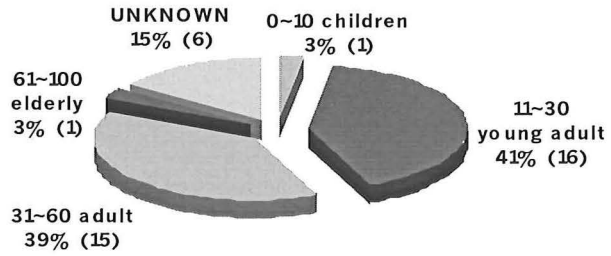

Figure 83 Restaurant Injured Occupant Age Distribution

Figure 83 shows that most of the injured occupants were aged from 11~60. The age group with highest percentage injury is from 20~30 then 30~40. There are not too many young children nor elderly people who have been injured. The reason suspected is that most injured occupants were employees inside the restaurant where most fires started. And most occupants were injured while they were trying to fight the fire (this will be demonstrated later in this paper).

Occupant Familiarity

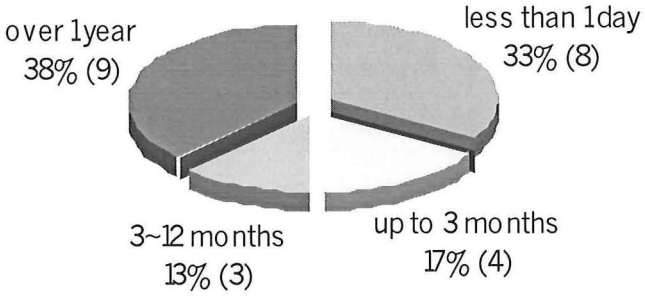

Figure 84 Restaurant Injured Occupant's Familiarity

It is shown in Figure 84 that most injured occupants are reasonably familiar with the surroundings. Although there are still some who had less than 1 day of familiarity, they are possibly customers of the restaurant rather than the workers. The pie chart is evenly spread, and there are no strong trends to show a direct relationship between familiarity and injury.

Cause of Injury

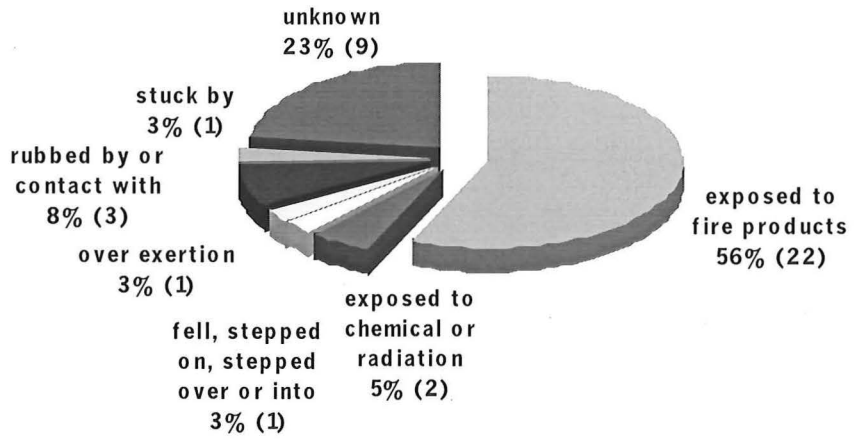

Figure 85 Restaurant Injured Occupants ' Cause of Injury

It is shown in Figure 85 that most injured occupants were hurt from the harmful fire products more than all the other fire incidents.

Activities of Injury

It is shown in the provided data that most of the injured occupants were trying to fight the fire when injured (56.4%), the rest of them was unable to act for some known or unknown reason. It also indicates that most of the injured occupants were probably employees of the restaurant, the occupants seemed to think its part of their duty to control the fire. This finding also addressed the need to educate the general public about the danger of fire such as fighting without training. At the same time, it highlighted the importance of employee fire training.

Condition of Occupants before Injury

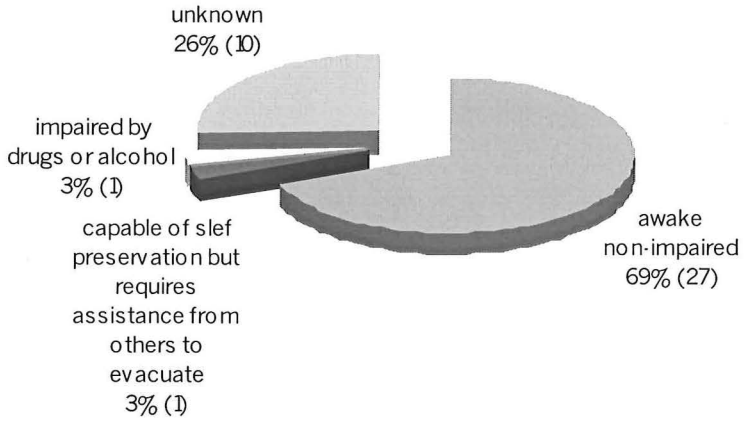

Figure 86 Restaurant Injured Occupants' condition before injury

Figure 86 shows that most of the injured occupants were awake and non-impaired, which means that they should have been able to react to the incident and been capable of escaping. Therefore the real cause of injury – fire control attempt is the real main cause of injury rather than exposure to fire products.

Location of Occupants at Ignition Time

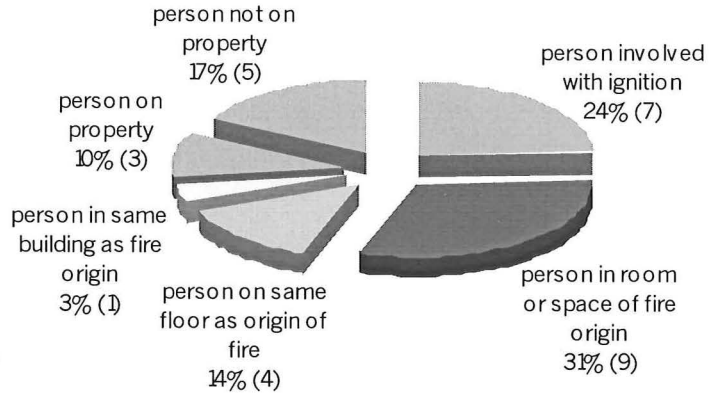

Figure 87 Location of restaurant Occupant at Ignition Time

It is shown in Figure 87 that the highest percentages of injured occupants were in the room of the fire origin or on the same floor as the fire origin. This also agrees with the fact that most occupants were trying to control the fire when they were injured. Since most injured occupants were in the same room as the fire origin, they were the first ones who saw the fire and the first idea that come into their mind was often to fight the fire.

Factors Preventing Escape

From the limited database, most of the factors that prevent occupants from escaping safely were not the time to escape or the occupants moving too slowly but probably the desire of the occupants to fight the fire.

9 TAKEAWAY BARS/LUNCH BARS/FISH & CHIPS

Among all the Commercial Industries especially the Food and Beverage Sales, there was a special category that was not classified into the hospitality industry under the ANZSIC classification. They were very similar to hospitality, and that was Takeaway bars/Lunch bars/Fish & chips. It was very similar to hospitality especially the restaurant category, the main purpose was to provide food as a service, and therefore detailed analysis has been done treating it as a separate section and comparing it with the others.

Note that in some parts of the following section the designated Takeaway bars/Lunch bars/Fish & Chips is shortened to "Takeaway bars".

9.1 General Information

9.1.1 Incident Time Distribution

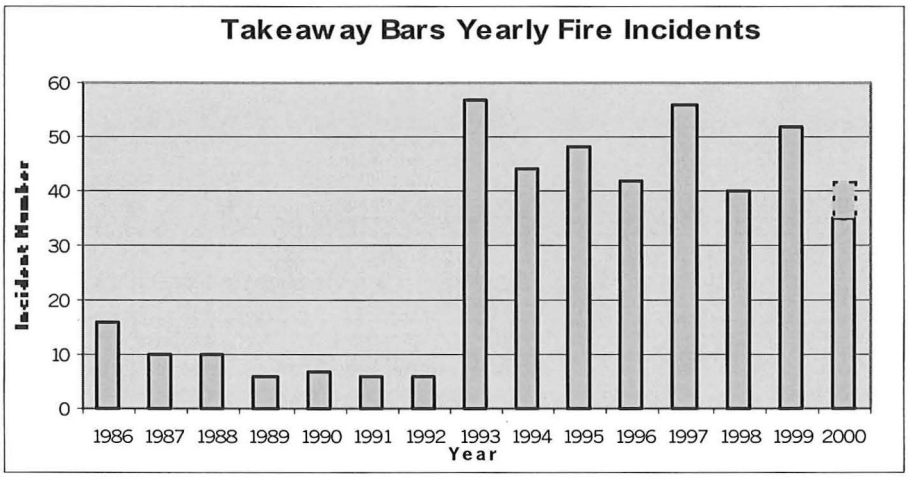

Figure 88 Takeaway Bars Yearly Fire Incidents 1986~2000

Figure 88 shows that there is clearly a big jump in the fire incident number of the Takeaway bars/Lunch bars/Fish & chips category. The reason is not at all clear but it is suspected that the increase in the fire incident number might have something to do with the increase in the establishments, but further research is needed to make a clear conclusion upon this.

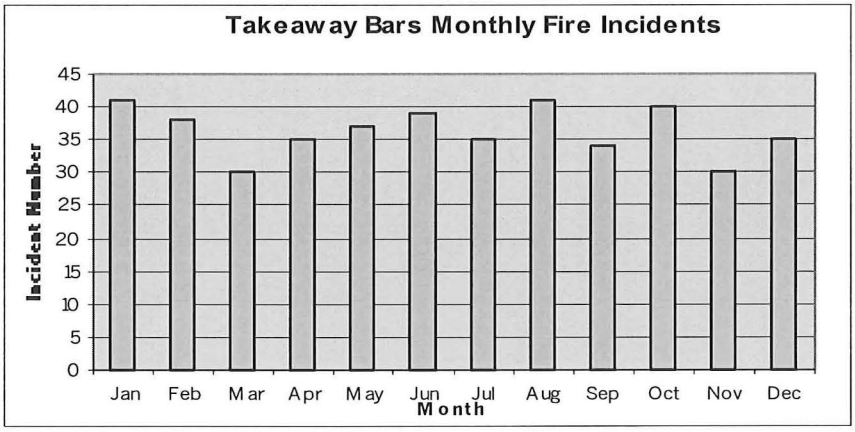

Figure 89 Takeaway Bars Monthly Fire Incidents

Figure 89 shows that there is no strong trend of high risk in fire for any particular month. However, a small variation can still be seen. Generally speaking, August is the most risky month, which is the same as what have been discussed previously in section 5.3.2, it might be due to the heavy usage of heating devices. March and November together stand for the months with the lowest takeaway bar fire incidents.

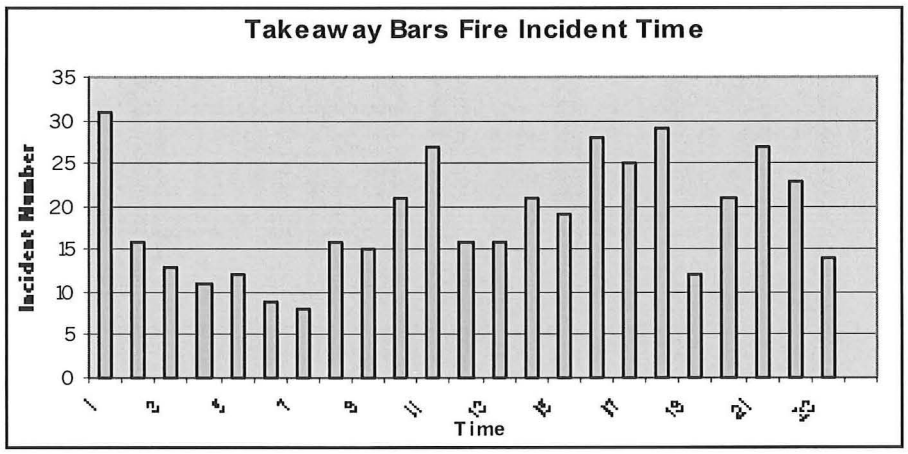

Figure 90 Takeaway Bars Fire Incident Times

It is shown in Figure 90 that there is quite a lot of variation in incident happening time, fire incidents generally happen a lot more in the daytime rather than at night time (sleeping time). This might be related to the operating time of Takeaway bars. One interesting feature is that the peak incident number happened at about 1am in the morning when most of the shops were closed. It is suspected that most of these fires were due to electrical defaults or arson.

9.1.2 Incident Type

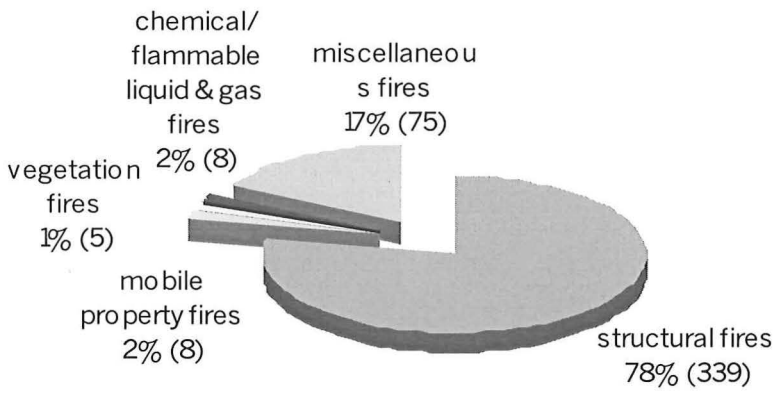

Figure 91 Takeaway Bars Fire Incident Types

Figure 91 shows that just like in all other fire incidents, most of the fires were structure related fires.

9.1.3 Incident Causes

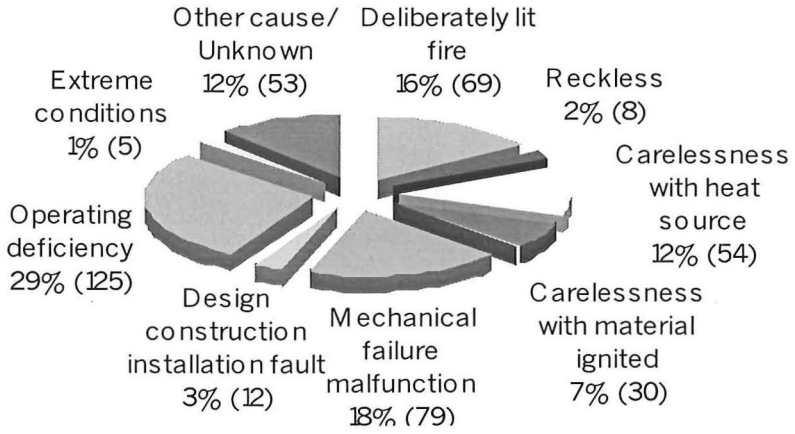

Figure 92 Takeaway Bars' Fire Incident Causes

Figure 92 shows that the greatest cause of incidents as a group is operating deficiency. Within this group, failure to clean is the main possible reason of fire. Looking at each cause separately, the main cause of fire incidents in this category is unattended equipment, followed by unlawful operation then careless disposal. These incident causes are very similar to the restaurant category.

9.1.4 Location of Fire Origin

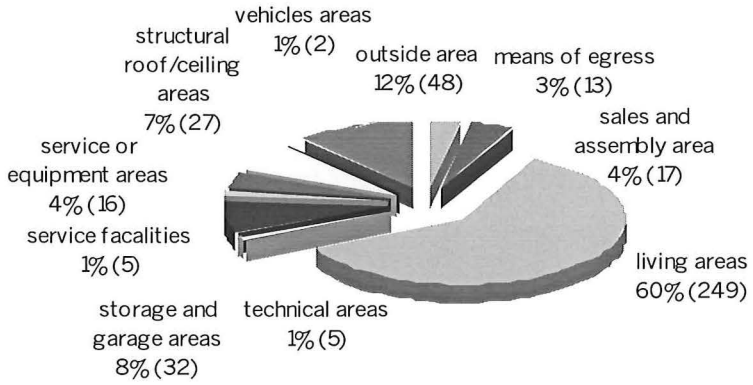

Figure 93 Takaway Bar Fire Incidents' Fire Origin

It is shown in Figure 93 that as in all hospitality fire incidents, the living area is the most risky area. As far as for Takeaway bars/Lunch bars/Fish & Chips, not surprisingly the area, which stands for the highest incident percentage, is the kitchen (54%). All the other possible fire origins have no close incident numbers to this. Along with the findings in the restaurant category (section 8), this again emphasised the need to look out for fire protection in the kitchen.

9.1.5 Incident Heat Sources

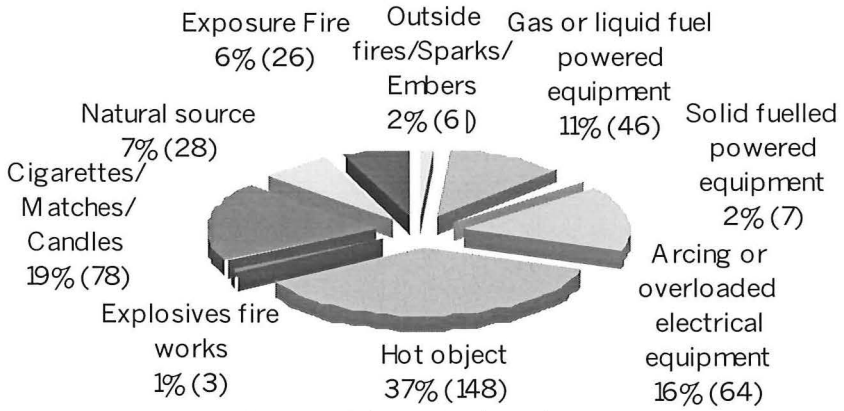

Figure 94 Takeaway Fires' Heat Sources

It is shown in Figure 94 that in the highest percentage of Takeaway bar fire incidents the heat source is hot objects. Individually, heat from electrical equipment if properly used, stands for the largest proportion (25%). Other heat sources are nowhere close to this in terms of percentage.

9.1.6 Ignited Objects/Material

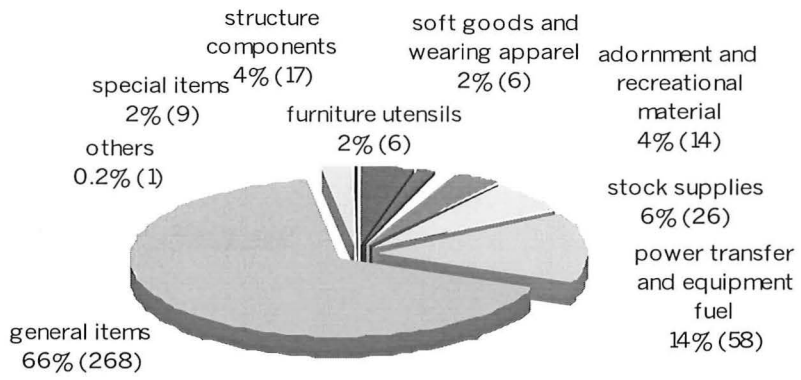

Figure 95 Takeaway Bars' Ignited Objects

Figure 95 shows that most ignited objects are general items. Among all the general items, not surprisingly, cooking material/food stands for the highest percentage (45.3%). This finding again matches with what has been found in section 8 in the restaurant category.

9.1.7 Building Area

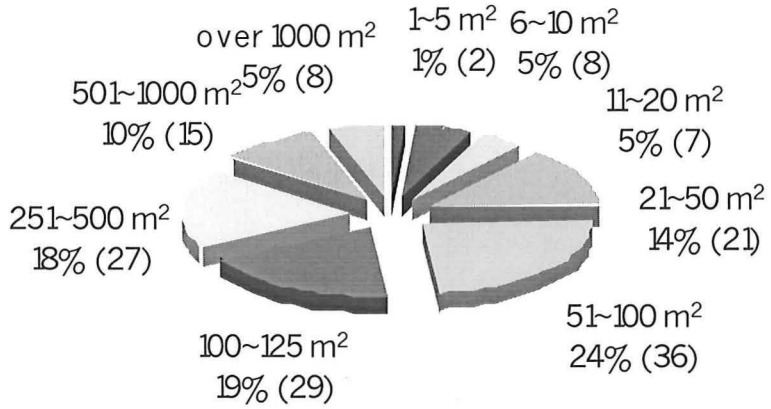

Figure 96 Takeaway Bars Incident Building Area

It is shown in Figure 96 that compared to the building area of all other hospitality categories. Takeaway bars/Lunch bars/Fish & chips generally have a smaller building area. This might have something to do with the fact that this type of food provider is not designed/intended for a long dining time. Normally people come and pick up the food and go, or they might stay only for a shorter meal in comparison to other types of food providers.

9.1.8 Construction Type

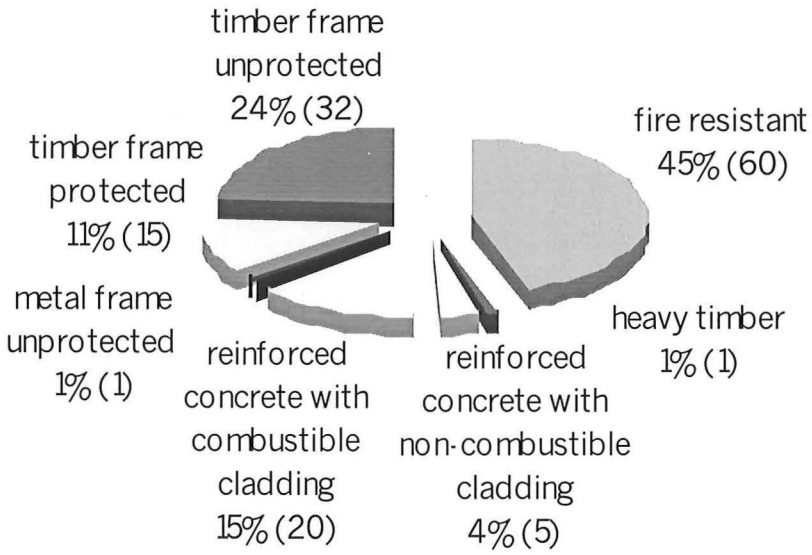

Figure 97 Takeaway Bar/Lunch Bar/Fish & Chips Construction Type

Figure 97 shows that most properties within this category were constructed of fire resistant material. Although fire incidents still occurred, neither fatality nor burn out of adjacent property happened. It is essential to note the importance of using passive protection for this type of high-risk industry/category in terms of fire spread prevention.

9.1.9 Material Generating Most Flame/Smoke

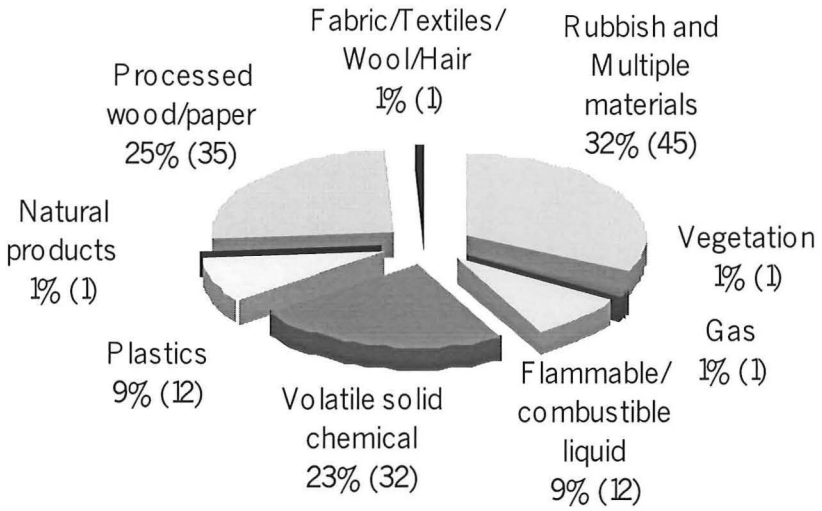

Figure 98 Takeaway Bars' Ignited material that generating Most Flame

Figure 98 shows that rubbish and multiple materials generated most flame as a group. When looking into each smaller part, apart from the multiple materials, fat and grease are the ones that generated most flame. This again stresses the need for special fire protection in food providing industries especially in kitchen areas.

9.2 Injured Occupants

Among the 435 fire incidents within this category, there were only 11 injuries and no fatalities. Further, all injuries were only from slight to moderate conditions (not life threatening). Now looking into the details to see if there are any trends within the occupants' behaviour. Since there were not that many injury data, the findings in this section might not have sufficient statistical importance therefore the findings could only be used as an indication.

Occupant Age

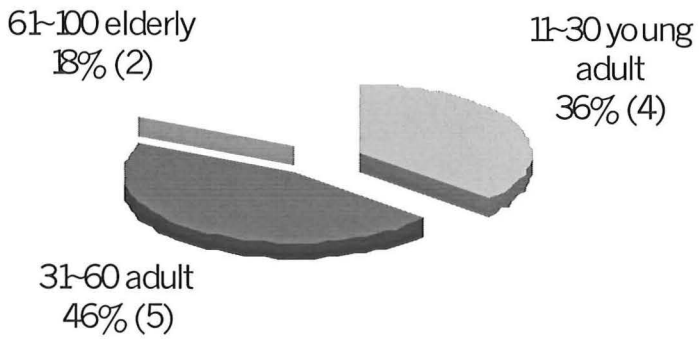

Figure 99 Takeaway Bars Injured Occupants' Age Distribution

The age group with the highest injury with moderate severity is 20~30.

Occupant Familiarity

Apart from the unknown ones, 5 injured occupants in this category had familiarity to the environment of less than one day. They were suspected to be customers of the shop. Out of the 11 reported injuries there were 3 occupants with high familiarity to the environment (3 months and above).

Cause of Injury

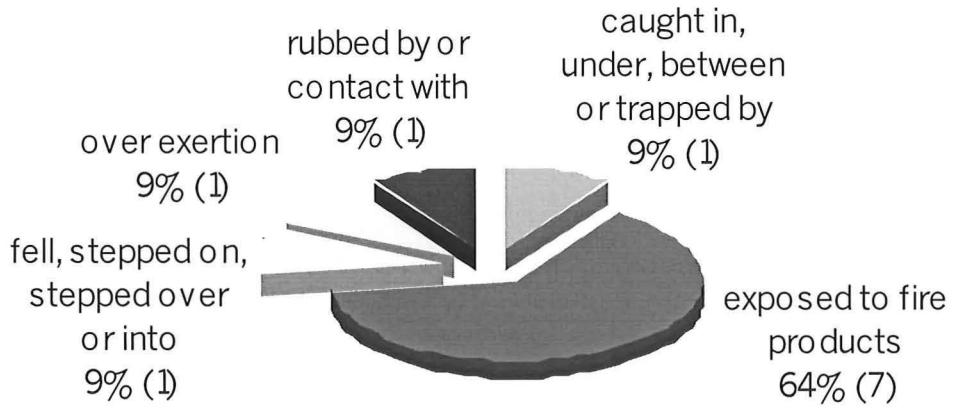

Figure 100 Takeaway Bars Fire Incident Occupants' Cause of Injury

Figure 100 shows that as in all the other fire incidents in other categories (as discussed previously), most occupants were injured from exposure to fire products. They are the most harmful.

Activities of Injury

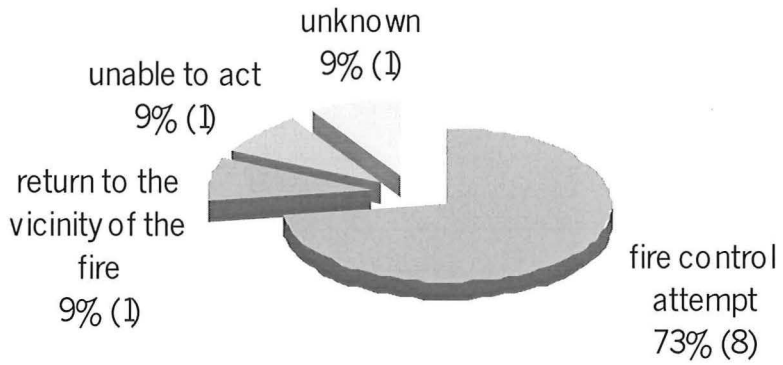

Figure 101 Takeaway Bar Occupants' activity when injured

It is shown in Figure 101 that most of the injured occupants were trying to fight the fire when injury occurred, which is the same as what has discussed in section 8.2. There were 1 occupant who returned to the vicinity of fire and the other one who was unable to act for some reason.

Condition of Occupants before Injury

From the given detail of the injured occupants, almost all of the occupants were awake besides the 2 elderly occupants (both 95 years old) who were impaired by drugs or alcohol. This finding is not at all surprising due to the fact that most fire incidents within this category occurred in the daytime, and the buildings are mainly used for short-term purpose (mainly just the waiting period, at most 1~2 hours fast food).

Location of Injured Occupants

Besides the unknown ones, most occupants were in the room or space of fire origin. It is expected that this kind of property usually does not have a great building area. It is also shown that occupants were close to the fire when it started, so they attempted to control the fire.

Factors Preventing Escape

There were three most obvious factors preventing occupants from escaping in this category. The main factor is that occupants moved too slowly and the other two are lack of time to escape and locked or blocked exit way.

10 CONCLUSIONS

(For tabulated information please refer to Appendix C)

It is emphasised that the results presented and the conclusions made in this report were based only on hospitality fire incidents that were attended by the New Zealand Fire Service and classified under ANZSIC Code. Also in some cases the sample size was too small to allow for meaningful statistical analysis therefore only indications could be drawn.

The general conclusions based on observation made from this research are that:

- Hospitality industry fire incidents have slowly decreased since 1998.
- The highest fire risk month was August, which was likely due to the higher use of heating devices during wintertime.
- Out of the 3652 hospitality industry fire incidents (defined by the SPUse), there were 122 incidents with 196 casualties in total, and 12 fatal fire incidents with 26 fatalities in total.
- Restaurant/Cafeteria/Diner as a category stood for the highest percentage of fire incidents and incidents with casualty, but no fatality had ever occurred.
- Boarding house and Hotel/Motel/Lodges without liquor license both had the highest percentage of fatal fire incidents.
- Within all short-term accommodation, Hotel/resort had the most out-weighted fire incidents, and Caravan parks had the most out-weighted fire incidents with casualty.
- Top three incident causes were careless disposal, suspicious and failure to clean for hospitality industry.
- Caravan fire incidents have dropped dramatically since 1993.
- Fire incident in Hotel/Motel/Lodges without liquor license dropped since 1993. This might be due to the fact that more hotels are getting liquor licenses.
- Almost all of the fatal fire incidents were in the accommodation type categories.

Some specific conclusions reached as a result of this research are that:

- Most fatal fire incidents occurred in bedrooms at night time when occupants were still asleep. Heat sources were mostly from electrical equipment and ignited bedding/blankets.
- Most incidents with injury occurred in kitchens due to careless action. Heat was mostly from gas fuelled equipment and ignited cooking material/food etc. Most of those suffering injuries were awake and non-impaired. Injuries were due to attempts at fire control.
- Most of the fatalities and injured occupants were hurt from exposure to fire products, and they were not necessarily in the same room or space of fire origin.
- A large proportion of the fatal fire incidents and the incidents with injury happened in unprotected timber structures with most fire types being structural flashover fires. Since according to the provided data the material that produces most smoke is sawn-timber, it is not surprising that most occupants were injured or killed by exposure to fire products.
- Restaurants and Takeaway Bars/Lunch Bars/Fish & Chips had some characteristics in common:
    - Fire incidents in both categories started to go up since 1993.
    - Most fire incidents occurred at night but not during sleeping hours. The cause of most fire incidents was operating deficiency in the kitchen area.
    - Both categories had fire incidents occurring from a heat source, being heat providing equipment and also most of the material that got ignited was cooking material/food.
    - Injuries occurred in around 4% of fire incidents, but there were no fatalities. Most occupants were awake and non-impaired but injured when fire control was attempted. Occupants were mainly located in the room or space of the fire origin, which matches the fact that they were trying to fight the fire.
    - Both differ from the other categories; in that most construction types were fire resistant and almost all incidents were structural fires but non-flashover.

11 RECOMMENDATIONS

The following recommendations are made:

11.1 Further Research

That further research/study be made into the following:

- The possibility of dividing accommodation and food providing categories into two different industries rather than as one general term "Hospitality Industry". The two types of categories have very different characteristics under fire; therefore a mixture of the two might be misleading.
- The reason for the number of incidents dropping since 1997 could be used as a model to follow for other industries too.
- Detailed analysis should be made into Hotel/Resort fire incidents, since there are an usually high number of incidents within all the short-term accommodation type categories.
- The cause of Campsite/Caravan fire incident number dropping since 1993, and the main reason why this has an unusually high number of casualty incidents in comparison with all the short-term accommodation categories.
- Cause of flashover fires, since most casualty fires were related to flashover fire.
- The reason for Hotel/Motel/Lodges and Boarding house standing for most fatal fire incidents.
- In the provided database the use of detection systems for each incident were not at all clear. It was suspected that most severe fire incidents, especially the ones with casualties, were the ones without detection systems or faulty detection systems. Further research needs to be done to examine the relationship between the usage of detection systems and the severity and damage of the fire. Also a cost benefit analysis might need to be carried out.
- The actual establishments/building number within each of the subcategories for more accurate analysis to be made.

11.2 Methods for Eliminating Fire Starting or keeping the fires small:

11.2.1 Recommendations From This Report

Public Education

- According to this report, most occupants were injured due to improper fire control, therefore short but sharp TV commercials are advised to improve the quality of the general public's fire protection knowledge.
- Short term courses with certificate e.g. workplace fire protection. This is particularly important for properties providing accommodation such as Hotels.
- Publish a layman's guide to fire precautions, which is also to increase the general public's fire protection and control knowledge.

Detection/Suppression

- Suitable extinguishers should be provided and the employees must be trained in how to use them e.g. the best way to put out a fat pan fire is to smother it. (Glass fibre blanket should be available to use.) This also reflects the fact that most occupants were injured in Kitchen from fire control action.
- According to the findings of this report, many flashover fires were associated with unprotected timber frame structures, where most fatalities and injuries occurred. Therefore encourage the use of fire resistant structure especially around possible fire origins eg. Kitchen.

Security

- To avoid arson fires a good standard of security outside hours of occupation must be provided. Floodlighting of rear yards can be a good deterrent.
- Prevent building access through doors other than entrances by keeping them locked. Fire exits should be openable from the inside, but simple audible devices can dissuade people from using them unofficially.
- Prevent the public from gaining access to non-public areas by keeping doors secured.
- Keep storerooms locked with access only to authorised employees.

Housekeeping

- Good housekeeping inside and outside the buildings. External rubbish bins and waste material should not be easily accessible since they are the possible fire origin for arsonists. What about skips with lockable metal lids? Rubbish should be collected regularly and stored in a secure place pending removal, or well away from buildings.
- According to this report, smoking material stands for a large proportion of the heat source. Therefore, providing plenty of suitable ashtrays and ensuring they are emptied regularly is essential.
- Clean up kitchen areas daily, especially areas around possible heat sources, making sure no grease is left on top since kitchen is the number one fire origin within this industry.

Law Enforcement

- Employees should be discouraged from smoking on the premises. Smoking should be prohibited in food preparation areas and in all storerooms.
- Hotel rules should be strictly enforced such as non-smoking areas.

Training

- Information and training to hoteliers and staff should be monitored in such a way as to ascertain their real level of knowledge eg. Some form of recognised certificate. This also reflects what has been mentioned previously in the public education such as a work place fire protection certificate.
- Ensure that staff are instructed and trained in the use of the equipment.

Installation, inspection, monitoring and maintenance

- Ensure that appliances-especially deep fat fryers-are fitted with suitable thermostats which are regularly checked and maintained, since they are obviously a hotspot for fire to start.
- Ensure that gas and electric supplies are properly installed to modern standards to minimise the chance of fire originating from electrical faults.

- Gas and electricity supplies should be located with switches and valves, which can be easily turned off if the appliance is on fire especially in public places such as a restaurant kitchen.
- Extraction hoods must incorporate self-draining grease traps and filters to avoid the condensation of grease in their interior. Also clean frequently.
- According to this report, most occupants were injured in the kitchen when attempting to control the fire, therefore an auto-suppression system for cooking appliances such as an exhausting hood could be used to reduce the chance of occupants having to fight the fire manually.

General

- Flame-retardant curtains and fabrics etc to keep the fires small even though they have been started accidentally.

11.2.2 Recommendations From Other Sources [9] [16] [17] [18]

Detection

- From international experience, detection is protection. Encourage the installation of sprinkler systems for properties with sleeping occupancies, and properties with likely fire origins eg kitchens in restaurant.
- Some people believe smoke detectors should be installed within the bedrooms rather than in the corridors, but solutions to overcome false alarms, need to be carefully designed.

Insurance

Civil (or Public) Liability insurance should be made compulsory for hoteliers. This is the only provision that would enable clients who have suffered a loss to be sure of obtaining compensation when it has been awarded by the court.

Installation, inspection, monitoring and maintenance

- Use independent bodies for monitoring and inspecting technical equipment. Where hoteliers fail to observe equipment maintenance obligations, sanctions should be imposed. It is only penalties that directly affect the running of a hotel that prove to be really effective. Notices of temporary closure or prohibition from dealing with tourist offices or tour operators would be appropriate.
- Installation should be checked every year.
- Earth leakage circuit breaker protection should be provided at the main switchgear.
- Avoid the use of temporary installation, multiple socket adaptors and trailing leads.
- Careful installation to avoid over heating of adjacent combustibles.

Hotel associations and tourist offices

- Hotel associations should be invited to spread information through their periodical publications. A fire safety classification system, based on objective criteria should be established. Any ungraded hotels should be excluded from tourist office lists (safety register).
- Could design a star rating system for the standard of fire safety, or combined with the existing quality hotel rating system.

General

- Fire safety director for all high-rise buildings (not that many high rise buildings in NZ but worth having for several major buildings such as Park Royal.)
- Power to close a building until fire procedures are fully investigated to be given to the fire service or the councils, and power to spot-check such buildings later on.

12 REFERENCES

1. Private communication with Mr. Mark Chubb of New Zealand Fire Service.
2. *New Zealand Fire Service Fire Incident Reporting System Instruction & Coding Manual.* (for data collected after 1 July 1995) Planning and Review Division, National Headquarters.
3. Australian and New Zealand Standard Industrial Classification (ANZSIC).
4. *Hotel and Motel Fire Safety Act of 1990 (Public Law 101-391).* Federal Emergency Management Agency, Dec 1992.
5. *Fire In the United States 1985-1994.* Federal Emergency Management. pp. 44-113.
6. *Fire Prevention and Control Guidelines for Places of Public Accommodation.* Public Law 101-391. Sept. 25, 1990.
7. *Britain Controls Hotel Fire Safety.* Fire International. No. 56, 1997. pp. 23-27.
8. Catchpole. L. *CFPA Europe Conference 1994 – Hotel Fire Safety.* Fire Prevention 268 April 1994. pp.13-15.
9. *Hotel fire safety.* Fire Prevention 298 April 1997.
10. Lancaster. G. *Raising safety standards in European hotels.* Fire Prevention 275 Dec 1994. pp.18-19.
11. *NFPA No. FR74-1 1974 - A Study of Restaurant Fires.* NFPA National Fire Protection Association.
12. New Zealand Fire Service Fire Incident Reporting System database. 1986-2000.
13. *New Zealand Fire Service-EMERGENCY INCIDENT STATISTICS 1993-1997.*
14. Statistics New Zealand Web site http://www.stats.govt.nz. *Accommodation Survey May-Sep 2000. Annual Enterprise Survey 1998.* Statistics New Zealand.
15. Narayanan. P. & Whiting. P, 1996. New Zealand Fire Risk Data. Study Report No. 64. Building Research Association of New Zealand.
16. Crossland. J.W. *Fire Precautions in Public Houses and Restaurants – an insurance view.* Fire Surveyor v.18 no.6. 1986. pp.9-16.
17. Louderback. J. *Hotel Safety in the States.* Fire International Sep 1996. pp.24-25.
18. Wigger. H.J. *Detection is protection.* Fire International Sep 1996. pp.31-32.

13 BIBLIOGRAPHY

1. Alalouff. R. *Fire standards in the Asia-Pacific area.* Fire International Sep 1996. pp.33.
2. *Are hotels sufficiently safe from fire?* Fire Prevention 250 June 1992.
1. Bell, R. *Fire Protection Handbook Section 8/Chapter 16 – Hotels.* Fire Protection Handbook (18th ed) National Fire Protection Association. pp. 119-121.
2. Brennan. P. *Successful Evacuation in Smoke: Good Luck, Good Health or Good Management?* INTERFLAM'99. pp. 697-706.
3. Brooks. H. *Electronic sensor uses "nose" to detect fires.* Fire International Sep 1996. pp.34.
4. Bush. K. *Apartment Buildings.* Section8/Chapter 17. Fire Protection Handbook. pp.8-123.
5. Dowling. P & Ramsay. G.C. *Building Fire Scenarios – Some Incident Statistics.* CSIRO Building, Construction and Engineering.
6. Dowling, V.P & Ramsay, G. (1996) *Building Fire Scenarios – An Analysis of Fire Incident Statistics.* CSIRO Division of Building, Construction and Engineering, Fire Code Perform Centre Ltd.
7. *Fire '91 – Fire costs – Hotel fire safety – the wider dimensions.* Fire Prevention 245, Dec 1991.
8. *Fire Protection in the Lodging Industry.* American Hotel & Motel Association 1988.
9. Gardner. J. Comparing smoke vent systems in shopping malls. Fire prevention 236 Jan/Feb 1991.
10. Gunn. D. *Fatal Hotel Fire in New Zealand.* Fire International Sep 1996. pp.22.
11. Hall. J.R. *A Tale of Fire Safety Programs That Work – Two Decades of Hotel/Motel Fires.* NFPA Journal July/August 1996. pp. 55-61.
12. Hall. J.R. *International Fire Comparison Report # 1 – Fire in the U.S.A and Japan through 1994.* Fire Analysis & Research Division of National Fire Protection Association.

13. Hall. J.R. *International Fire Comparison Report # 2 – Fire in the U.S.A and Canada through 1994*. Fire Analysis & Research Division of National Fire Protection Association.
14. Hall. J.R. *International Fire Comparison Report # 3 – Fire in the U.S.A and Sweden through 1996*. Fire Analysis & Research Division of National Fire Protection Association.
15. Hall. J.R. *International Fire Comparison Report # 4 – Fire in the U.S.A and United Kingdom through 1995*. Fire Analysis & Research Division of National Fire Protection Association.
16. Hancock. D. *The case for staged alarms and phased evacuation in hotels*. Fire Prevention 275 Dec 1994. pp.14-17.
17. Jones, C. *A Brief Look At The Hotel Fire Record*. Fire Journal May 1981. pp. 38-46.
18. Kannangara. J. *Massive fires after Colombo bomb blast*. Fire International Sep 1996. pp.29.
19. Kellet. J. & Forte. T. *Fire International'90 – The European situation.. – Developments in hotel fire safety*. Fire Prevention 234, Nov 1990.
20. Kidd. S. *Hotel fires – the facts*. Fire Prevention 236 Jan/Feb 1991.
21. McEwen.T & Miller. C.A. "*Fire Data Analysis Handbook*" Federal Emergency Management Agency US Fire Administration.
22. Nelson. H.E. *Fire Modelling Assessment of Areas of Refuge Intended to Provide Safety Fore Persons With Mobility Limitation*. Hughes Associates Inc. USA. INTERFLAM'93. pp.161-170.
23. Nelson. H.E. *An engineering analysis of the early stages of fire development – the fire at the Dupont Plaza Hotel and Casino – December 1986*. U.S. Department of Commerce.
24. *News – European Commission calls for survey of hotel fire safety in Europe*. Fire Prevention 273 Oct 1994.
25. News – China hotel fire kills 29. Fire Prevention 292 Sep 1996.
26. *News - Focus on fire risks in hotels*. Fire Prevention 237, March 1991.
27. *News – No conferences without sprinklers*. Fire Prevention 218, April 1989.
28. Nicholson. D. *Safety can be a marketing bonus*. Fire International Sep 1996. pp.26.

29. *Occupancy Fire Record – Restaurants*. National Fire Protection Association 1955.
30. Products and services – Wormald takes on kitchen fires. Fire Prevention 222 Sep 1989.
31. Proulx. G. & Fathy. R. *The Time Delay to Start Evacuation: Review of Five Case Studies*. Fire Safety Science – Proceedings of the Fifth International Symposium. pp 783-794.
32. Proulx. G. *Fire Risk Management*. Construction Innovation, Volume 4 Number 3 Spring/Summer 1999.
33. Proulx. G. *Critical factors in high-rise evacuations*. Fire Prevention 291 July/August 1996. pp. 24-27.
34. Roberts. H.S. *Writing for Science*. Addison Welsley Longman New Zealand Limited.
35. Scoones. K. *Fires in hotels during 1990*. Fire Prevention 249 May 1992. pp. 11-19.
36. Sharry. J.A. *Real-World Problems with Zone Evacuation*. Fire Journal March 1983. pp. 32,33,55.
37. Tremblay. K.J. & Fathy. R.F. *Catastrophic Fires*. NFPA Journal September/October 1998. pp. 42-57.
38. Tudhope. H. *Technical information service – Restaurant fire safety*. Fire Prevention 204, Nov 1987.
39. Wahlstrom. B. *Azerbaijan underground blaze report*. Fire International Sep 1996. pp.35.

14 APPENDICES

14.1 Appendix A: Original Hospitality Fire Incidents Database

Database GPU/SPU

General Property Use	Specific Property Use	#	Sum
0 Not Applicable	4301 boarding house	1	
	4401 hotel/motel/lodges with liquor license	5	
	4402 hotel/motel/lodges without liquor license	8	
	5104 restaurant/café/diner	2	
	5107 pub/tavern/inn	3	**19**
11 Non-existent address	5106 takeaway bars/lunch bars/fish & chips	1	**1**
Construction			
21 Vacant building/section	4301 boarding house	4	
	4401 hotel/motel/lodges with liquor license	2	
	4402 hotel/motel/lodges without liquor license	4	
	5104 restaurant/café/diner	9	
	5106 takeaway bars/lunch bars/fish & chips	5	
	5107 pub/tavern/inn	3	
	5108 nightclub	1	**28**
22 Construction/Renovation/Demolition	4504 children's playhouse	1	
	4402 hotel/motel/lodges without liquor license	1	**2**
Residential			
31 Single house	4301 boarding house	65	
	4401 hotel/motel/lodges with liquor license	7	
	4402 hotel/motel/lodges without liquor license	48	

	5104 restaurant/café/diner	1	
	5107 pub/tavern/inn	1	**122**
32 Flats/Home units/Apartments	4301 boarding house	56	
	4401 hotel/motel/lodges with liquor license	1	
	4402 hotel/motel/lodges without liquor license	8	
	5104 restaurant/café/diner	2	**67**
33 Boarding house/Half-way house/Dormitories/Rooming&lodging	4301 boarding house	201	
	4401 hotel/motel/lodges with liquor license	3	
	4402 hotel/motel/lodges without liquor license	41	**245**
34 Hotel/Motel/Lodge/Timeshare	0 not applicable	1	
	1104 video games/housie	1	
	1105 cinemas/picture theatres	1	
	1199 unable to classify recreation places (fixed use)	5	
	1201 gymnasiums/ballrooms/dance halls	2	
	1204 grandstands/stadiums/Sportsfield	2	
	1205playgrounds/parks	2	
	1299 unable to classify recreation places (variable use)	8	
	1401 sports clubrooms	9	
	2299 unable to classify schools(residential and boarding)	1	
	3602 IHC institutions	1	
	4101 single house	73	
	4200 not applicable flats/home units/apartments	3	
	4201 flats/home units/apartments (1 unit)	2	
	4203 flats/home units/apartments (3 units)	4	
	4211 flats/home units/apartments (11 units)	1	

	4301 boarding house	41	
	4302 half-way houses	1	
	4303 university/school etc	2	
	4306 bunk house/workers' barracks	9	
	4399 unable to classify boarding and half way houses/dormitories	21	
	4401 hotel/motel/lodges with liquor license	592	
	4402 hotel/motel/lodges without liquor license	777	
	4501 garage	19	
	4502 carport	1	
	4503 shed	10	
	4504 children's playhouse	1	
	4507 pool house	1	
	4508 tent	22	
	4850 ?	2	
	4899 ?	1	
	4999 ?	21	
	5104 restaurant/café/diner	37	
	5106 takeaway bars/lunch bars/fish & chips	3	
	5107 pub/tavern/inn	150	
	5108 nightclub	7	
	5110 liquor store	12	
	5199 unable to classify food and beverage sales	9	
	5302 furniture/furnishings/appliances/sales & repairs	1	
	5420 timber supplies	1	
	5422 hairdresser/beauty salon/barber's shop	1	
	5503 hotel supplies/restaurant/hospitality goods	1	
	5504 laundromat	1	

	5505 commercial laundry	1	
	5602 service station (private)	1	
	5604 mechanical repairs/auto-electricians/panel beaters/paint shops	2	
	5605 vehicle sales/motorcycles/trailersales/farm machinery	3	
	5699 unable to classify vehicle boat sales services	1	
	5801 offices (general business)	2	
	5806 fire stations/ambulance stations	1	
	6101 geothermal/steam powered/power station	1	
	6401 sub-stations/transfers/power lines	1	
	6405 water supplies/pipelines/reservoirs/tanks/treatment centres	2	
	6499 unable to classify utilities and energy distribution	1	
	6501 dairy/beef	1	
	6513 cereal	1	
	6599 unable to classify farming agriculture	2	
	6601 native	15	
	6604 single trees/hedges	5	
	6699 unable to classify trees/forests	1	
	7608 other industrial chemicals (hazardous)	2	
	7801 motor vehicle and parts/trailers/manufacture/assembly/coach building	2	
	8101 barns/silos/bins/bulk&loose/open storage	5	
	8102 canned/bottled	1	
	8106 freezers/frozen foods	1	
	8302 LPG	1	

	8401 firewood	1	
	8403 timberyards	1	
	8408 paper products/cartons/bags	2	
	8504 paints/varnishes/lacquers/inks/waxes/adhesives	1	
	8801 public carpark (uncovered)	72	
	8802 public carpark (single lever covered)	8	
	8803 public carpark multi storied above ground)	4	
	8805 public carpark (multi storied above and below ground)	1	
	8806 private carpark/fleet carpark (uncovered)	9	
	8807 private carpark/cars/buses/trucks (single level-covered)	1	
	8899 unable to classify mobile property storage and parking	4	
	8902 mixed goods/warehouse	3	
	8999 unable to classify general storage	4	
	9101 vacant buildings	8	
	9103 building under construction	1	
	9104 building under demolition	2	
	9106 structure under renovation	1	
	9199 unable to classify vacant building and construction sites	1	
	9201 fences	4	
	9202 mailbox	8	
	9205 telephone boxes/booths	1	
	9214 recycling bins	9	
	9215 contractors sheds	1	
	9299 unable to classify special structures	3	
	9301lawn areas/backyards/garden areas/patio areas	31	
	9302 vacant section	71	

	9303 open land	466	
	9304 roadside vegetation	2	
	9306 campsites/caravan sites/campervan parks	196	
	9307 cemeteries/uruupa	13	
	9308 national parks/national reserves	2	
	9399 unable to classify outdoor areas	129	
	9403 beaches/costal shorelines	1	
	9499 unable to classify water areas	1	
	9601 private roads	6	
	9602 public roads/driveways	13	
	9603 motorways	3	
	9701 taxiways/parking areas/loading ramps/open maintenance areas	1	
	9799 unable to classify roads and streets	1	
	9801 public tips	61	
	9803 rubbish transfer stations	1	
	9805 sewage disposal	3	
	9999 unable to classify	15	**3079**
39 Unable to classify Residential	4301 boarding house	4	
	4401 hotel/motel/lodges with liquor license	2	
	4402 hotel/motel/lodges without liquor license	2	
	5104 restaurant/café/diner	31	
	5106 takeaway bars/lunch bars/fish & chips	8	
	5107 pub/tavern/inn	1	
	5108 nightclub	1	**49**
	Hospitality		
41 Restaurant/Pub/Tavern	1102 indoor sports centre	1	
	1202 exhibition halls	1	
	1203 auditorium/concert hall	1	
	1205playgrounds/parks	3	
	1401 sports clubrooms	1	
	2103 primary school	2	

	2105 high school/colleges	2	
	2201 primary & intermediate classroom building	1	
	3101 rest homes with nursing care	16	
	3301 general hospitals (public and private)	1	
	4101 single house	31	
	4201 flats/home units/apartments (1 unit)	3	
	4203 flats/home units/apartments (3 units)	2	
	4301 boarding house	1	
	4401 hotel/motel/lodges with liquor license	23	
	4402 hotel/motel/lodges without liquor license	4	
	4501 garage	3	
	4503 shed	3	
	5101 supermarket (over 1000m2)	1	
	5102 supermarket (under 1000m2)	3	
	5103 dairy/butcher/fish shop/bakery/other food store	43	
	5104 restaurant/café/diner	588	
	5105 Sportsclubs with restaurants	13	
	5106 takeaway bars/lunch bars/fish & chips	126	
	5107 pub/tavern/inn	180	
	5108 nightclub	34	
	5110 liquor store	5	
	5199 unable to classify food and beverage sales	11	
	5302 furniture/furnishings/appliances/sales & repairs	1	
	5407 post shop	1	
	5423 massage parlours/strip clubs	1	
	5503 hotel supplies/restaurant/hospitality	2	

	goods		
	5603 marine refuelling	1	
	5702 shopping mall	2	
	6405 water supplies/pipelines/reservoirs/tanks/treatment centres	1	
	6604 single trees/hedges	2	
	7101 slaughtering/meat preparation/meat preserving	1	
	7105 canning/packaging/preserving	1	
	7108 bread/bakery products/biscuits etc	9	
	7111 potato chips/snack foods etc	1	
	7114 winery/wineyard/cider	1	
	7401 clothing/knitwear/hat	1	
	7505 paper/pulp/cardboard	1	
	8105 mixed foodstuffs/storage and warehousing	1	
	8106 freezers/frozen foods	1	
	8107 cool stores	1	
	8801 public carpark (uncovered)	41	
	8802 public carpark (single lever covered)	1	
	8803 public carpark multi storied above ground)	2	
	8804 public carpark (multi storied below ground)	1	
	8805 public carpark (multi storied above and below ground)	1	
	8806 private carpark/fleet carpark (uncovered)	8	
	8807 private carpark/cars/buses/trucks (single level-covered)	1	
	8899 unable to classify mobile property storage and parking	1	
	9101 vacant buildings	3	
	9102building under renovation	1	

	9103 building under construction	2	
	9204 public toilets	1	
	9208 ticket office/toll booth	1	
	9214 recycling bins	2	
	9299 unable to classify special structures	1	
	9301lawn areas/backyards/garden areas/patio areas	30	
	9303 open land	4	
	9304 roadside vegetation	2	
	9601 private roads	7	
	9602 public roads/driveways	2	
	9701 taxiways/parking areas/loading ramps/open maintenance areas	1	
	9999 unable to classify	1	**1246**
42 Shops/Shopping mall/Supermarket/Service station/Car yard/Massage parlour/Other sales use	5104 restaurant/café/diner	189	
	5106 takeaway bars/lunch bars/fish & chips	276	
	5107 pub/tavern/inn	8	
	5108 nightclub	17	**490**
43 Service&repair use/Dry cleaner/Laundromat/Mechanical workshop	4402 hotel/motel/lodges without liquor license	1	
	5104 restaurant/café/diner	1	
	5106 takeaway bars/lunch bars/fish & chips	1	**3**
44 Offices/Bank/Embassie/Fire&Ambulance station	4401 hotel/motel/lodges with liquor license	1	
	4402 hotel/motel/lodges without liquor license	1	
	5104 restaurant/café/diner	28	
	5106 takeaway bars/lunch bars/fish & chips	5	
	5107 pub/tavern/inn	1	

	5108 nightclub	5	**41**
45 Industrial & manufacturing	4401 hotel/motel/lodges with liquor license	2	
	5104 restaurant/café/diner	5	
	5106 takeaway bars/lunch bars/fish & chips	2	
	5108 nightclub	1	**10**
Educational			
47 School (pre-school through to secondary/high)	4301 boarding house	2	
	4401 hotel/motel/lodges with liquor license	1	
	5104 restaurant/café/diner	6	**9**
48 University/Polytech/Teacher's college/Other post-secondary	4301 boarding house	3	
	5104 restaurant/café/diner	8	**11**
49 Unable to classify educational	5106 takeaway bars/lunch bars/fish & chips	1	**1**
Medical/Health			
51 Hospital/Hospice/Test home/Rehabilitation centre	4301 boarding house	10	
	4401 hotel/motel/lodges with liquor license	1	
	4402 hotel/motel/lodges without liquor license	1	
	5104 restaurant/café/diner	2	**14**
Recreational Assembly			
61 Recreational use/Theatre/Indoor sports/Pools/Park	4401 hotel/motel/lodges with liquor license	3	
	4402 hotel/motel/lodges without liquor license	1	
	5104 restaurant/café/diner	45	
	5105 Sportsclubs with restaurants	4	
	5106 takeaway bars/lunch bars/fish & chips	6	
	5107 pub/tavern/inn	12	

	5108 nightclub	5	**76**
62 Zoo&Aquarium/Sportsfield/Stadium	4402 hotel/motel/lodges without liquor license	1	
	5104 restaurant/café/diner	2	
	5106 takeaway bars/lunch bars/fish & chips	5	
	5108 nightclub	1	**9**
63 Sports club/Health club	4402 hotel/motel/lodges without liquor license	1	
	5104 restaurant/café/diner	1	
	5105 Sportsclubs with restaurants	11	
	5106 takeaway bars/lunch bars/fish & chips	1	
	5107 pub/tavern/inn	6	
	5108 nightclub	13	**33**
64 Library/Museum/Art gallery/Courts	5104 restaurant/café/diner	4	**4**
65 Church/Cemetery/Religious use	4402 hotel/motel/lodges without liquor license	2	**2**
66 Community hall/Marae/Maori cultural use	4402 hotel/motel/lodges without liquor license	1	
	5104 restaurant/café/diner	2	
	5106 takeaway bars/lunch bars/fish & chips	1	**4**
67 Passenger terminal	5104 restaurant/café/diner	2	**2**
69 Unable to classify Recreational Assembly	5108 nightclub	1	**1**
Communications Technical			
74 Power station	5104 restaurant/café/diner	1	**1**
Agricultural Forestry			
81 Farming/Horticulture/Agricultural use	4301 boarding house	1	
	4402 hotel/motel/lodges without liquor license	2	
	5104 restaurant/café/diner	1	
	5107 pub/tavern/inn	1	**5**
82 Forest/Conservation area/National	4402 hotel/motel/lodges without liquor	2	

park/Open land	license		
	5107 pub/tavern/inn	1	**3**
Disposal			
84 Rubbish tip/Transfer station/Hazardous waste disposal	5106 takeaway bars/lunch bars/fish & chips	1	**1**
Transportation			
85 Road/Streets/Motorway	4402 hotel/motel/lodges without liquor license	2	
	5104 restaurant/café/diner	2	
	5106 takeaway bars/lunch bars/fish & chips	4	
	5107 pub/tavern/inn	3	
	5108 nightclub	2	**13**
86 Railway property	5106 takeaway bars/lunch bars/fish & chips	1	**1**
Water Area			
88 Stormwater/Harbour/Lake/River/Beach/ Waterfront area	4402 hotel/motel/lodges without liquor license	1	
	5107 pub/tavern/inn	1	**2**
Others			
91 Defence/Military use	5104 restaurant/café/diner	1	
	5107 pub/tavern/inn	1	
	5108 nightclub	1	**3**
99 Unable to classify	4301 boarding house	5	
	4401 hotel/motel/lodges with liquor license	1	
	5104 restaurant/café/diner	15	
	5106 takeaway bars/lunch bars/fish & chips	3	**24**
			5621

Ps. Shaded ones are no really related to hospitality/non-important ones, and being cut out from the original database.

14.2 Appendix B: Fatal Fire Incidents' Partial Detail

Fatal Fire Incidents 1986~2000

Key	alert-d	fire time	IncidentType	SPUse	ff-inj	civ-inj	ff-dead	civ-dead	HeatSrc	Cause
6A01 87369 00	1987	-	1101	4402	0	0	0	1	46	713
6A01 871409 00	18/10/87	13	1101	4301	0	0	0	1	0	313
2C05 8732 00	27/12/87	4	1101	4402	0	0	0	3	0	999
3C05 8950 00	17/06/89	4	1101	4402	0	0	0	1	17	399
3B01 91122 00	13/03/91	3	1101	4401	0	0	0	2	46	712
5A01 923052 00	20/11/92	4	1101	4301	0	4	0	7	0	311
5A01 9448 00	05/01/94	8	1402	5107	0	1	0	1	0	511
3D06 9454 00	09/06/94	5	1499	9306	0	0	0	1	61	211
1A11 9463 00	15/07/94	5	1203	9306	0	2	0	1	46	316
2A01 95180 00	04/02/95	3	1101	4402	1	1	0	6	0	114
5B01 95119 00	21/02/95	13	1101	4301	0	0	0	1	65	111
1461 99A055070 00	01/07/99	21	1101	4301	1	0	0	1	37	515

Fatality Fire Incident Ignited Object

Object Ignited	Material	Incident Number	Time	%
311 Mattress/Pillow	711 Fabric/Fibre	1	4	9.1
312 Bedding/Blankets/Sheets	711 Fabric/Fibre or 713 Wool/Mixtures	3	13 5 3	27.3
611 Electrical wire/Insulation	411 PVC	1	21	9.1
615 Flammable liquid and gases	211 Petrol	2	13	18.2
741 Cooking material/Food	311 Fat/Grease/Butter	1	-	9.1
815 Propellants/Aerosols	115 LPG	1	5	9.1
911 Multiples items	-	1	4	9.1
999 Unable to classify	-	2	-	18.2

14.3 Appendix C: Conclusion/Comparison Tables

NZ Hospitality Fire Incidents 1986~Sep2000

Total Incident in Database : 5621		
Incident in Hospitality : 3652		
Non-Casualty Incident	Incident with Casualty	Fatal Incident
3530	122	12
	Casualty Number	Fatality Number
	196	26

Fire Incident Distribution within Hospitality Industry 1986~2000

Hospitality Industry	Total Incident #	Incident with Casualty #	Fatal Incident #
4301 Boarding house	394 (11%)	23 (19%)	4 (33%)
4303 University/School etc	2 (0.1%)	-	-
4306 Bunk house/Workers' barracks	9 (0.2%)	1 (1%)	-
4399 Unable to classify rooming	21 (1%)	-	-
4401 Hotel/Motel/Lodges with liquor license	644 (19%)	19 (16%)	1 (8%)
4402 Hotel/Motel/Lodges without liquor license	909 (25%)	23 (19%)	4 (33%)
5104 Restaurant/Cafeteria/Diner	986 (27%)	33 (27%)	-
5105 Sportsclubs with restaurants	30 (1%)	2 (2%)	-
5107 Pubs/Tavern/Inn	372 (10%)	7 (6%)	1 (8%)
5108 Nightclub	89 (2%)	2 (2%)	-
9306 Campsites/Caravan sites/Campervan parks	196 (5%)	12 (10%)	2 (17%)
Total	**3652**	**122**	**12**

Comparison between hospitality incidents

	Fatal Incidents/Fatalities	Injuring Incident/Injuries	All Incidents
Time	Late night or early morning	-	-
Incident Causes	-	Carelessness (32%)	Mechanical failure malfunction (20%)
Heat Source	Heat from electrical equipment (25%)	Heat from gas fuelled equipment (15%)	Heat from electrical equipment (13%)
Fire Origin	Bedrooms (45%)	Kitchen (28%)	Kitchen (24%)
Object Ignited	Bedding/blankets (28%)	Cooking material/food (13%)	Cooking material/Food (15%)
Activity of Injury	Asleep (39%)	Fire control attempt (50%)	-
Condition Before	Asleep (65%)	Awake non-impaired (73%)	-
Occupant Age	11~20 (31%)	21~30 (28%)	-
Familiarity	Over 1 year (54%)	Over 1 year (28%)	-
Occupant Location	In same building (39%)	In same building (31%)	-
Cause of death/injury	Exposed to fire products (81%)	Exposed to fire products (69%)	-
Construction Type	Unprotected timber frame (75%)	Unprotected timber frame (61%)	Unprotected timber frame (25%)
MM Flame/Smoke	Sawn	Sawn	Sawn
Incident Type	Structural fires	Structural fires	Structural fires
Fire Type	Flashover fires (100%)	Flashover fires (72%)	Non-Flashover fire (17%)

Comparison between Restaurant and Takeaway Bars/Lunch Bars/Fish & Chips

	Restaurant	Takeaway Bars/Lunch Bars/ Fish & Chips
Incident Number	968	435
Injury Number	39	11
Year	Slowly goes up since 93 peak at 98 then drop	Sudden jump at 93
Month	-	-
Time	Night time but not sleeping hrs	Night time but not sleeping hrs
Incident Causes	Operating deficiency (30%) Failure to clean (13%)	Operating deficiency (29%) Equipment unattended (10%)
Heat Source	Hot object (26%) Heat from gas fuelled equipment (16%)	Hot Objects (37%) Heat from electrical equipment (25%)
Fire Origin	Kitchen (62%)	Kitchen (54%)
Object Ignited	Cooking material/Food (30%)	Cooking material/Food (45%)
Activity of Injury	Fire control attempt (56%)	Fire control attempt (73%)
Condition Before	Awake non-impaired (69%)	Awake non-impaired (82%)
Occupant Age	21~30 (36%)	21~30 (36%)
Familiarity	Extreme Over 1 year (38%) Less than 1 day (33%)	Less than 1 day (45%)
Occupant Location	In same room or space of fire origin (31%)	In same room or space of fire origin (45%)
Cause of death/injury	Exposed to fire products (56%)	Exposed to fire products (73%)
Construction Type	Fire resistant (34%)	Fire resistant (45%)
MM Flame/Smoke	Sawn (32%)	Fat/Grease/Butter (7%)-flame
Incident Type	Structural fires	Structural fires
Fire Type	Non-flashover fires (16%)	Non-flashover fires (11%)

FIRE ENGINEERING RESEARCH REPORTS

95/1	Full Residential Scale Backdraft	I B Bolliger
95/2	A Study of Full Scale Room Fire Experiments	P A Enright
95/3	Design of Load-bearing Light Steel Frame Walls for Fire Resistance	J T Gerlich
95/4	Full Scale Limited Ventilation Fire Experiments	D J Millar
95/5	An Analysis of Domestic Sprinkler Systems for Use in New Zealand	F Rahmanian
96/1	The Influence of Non-Uniform Electric Fields on Combustion Processes	M A Belsham
96/2	Mixing in Fire Induced Doorway Flows	J M Clements
96/3	Fire Design of Single Storey Industrial Buildings	B W Cosgrove
96/4	Modelling Smoke Flow Using Computational Fluid Dynamics	T N Kardos
96/5	Under-Ventilated Compartment Fires - A Precursor to Smoke Explosions	A R Parkes
96/6	An Investigation of the Effects of Sprinklers on Compartment Fires	M W Radford
97/1	Sprinkler Trade Off Clauses in the Approved Documents	G J Barnes
97/2	Risk Ranking of Buildings for Life Safety	J W Boyes
97/3	Improving the Waking Effectiveness of Fire Alarms in Residential Areas	T Grace
97/4	Study of Evacuation Movement through Different Building Components	P Holmberg
97/5	Domestic Fire Hazard in New Zealand	KDJ Irwin
97/6	An Appraisal of Existing Room-Corner Fire Models	D C Robertson
97/7	Fire Resistance of Light Timber Framed Walls and Floors	G C Thomas
97/8	Uncertainty Analysis of Zone Fire Models	A M Walker
97/9	New Zealand Building Regulations Five Years Later	T M Pastore
98/1	The Impact of Post-Earthquake Fire on the Built Urban Environment	R Botting
98/2	Full Scale Testing of Fire Suppression Agents on Unshielded Fires	M J Dunn
98/3	Full Scale Testing of Fire Suppression Agents on Shielded Fires	N Gravestock
98/4	Predicting Ignition Time Under Transient Heat Flux Using Results from Constant Flux Experiments	A Henderson
98/5	Comparison Studies of Zone and CFD Fire Simulations	A Lovatt
98/6	Bench Scale Testing of Light Timber Frame Walls	P Olsson
98/7	Exploratory Salt Water Experiments of Balcony Spill Plume Using Laser Induced Fluorescence Technique	E Y Yii
99/1	Fire Safety and Security in Schools	R A Carter

99/2	A Review of the Building Separation Requirements of the New Zealand Building Code Acceptable Solutions	J M Clarke
99/3	Effect of Safety Factors in Timed Human Egress Simulations	K M Crawford
99/4	Fire Response of HVAC Systems in Multistorey Buildings: An Examination of the NZBC Acceptable Solutions	M Dixon
99/5	The Effectiveness of the Domestic Smoke Alarm Signal	C Duncan
99/6	Post-flashover Design Fires	R Feasey
99/7	An Analysis of Furniture Heat Release Rates by the Nordtest	J Firestone
99/8	Design for Escape from Fire	I J Garrett
99/9	Class A Foam Water Sprinkler Systems	D B Hipkins
99/10	Review of the New Zealand Standard for Concrete Structures (NZS 3101) for High Strength and Lightweight Concrete Exposed to Fire	M J Inwood
99/12	An Analytical Model for Vertical Flame Spread on Solids: An Initial Investigation	G A North
99/13	Should Bedroom Doors be Open or Closed While People are Sleeping? - A Probabilistic Risk Assessment	D L Palmer
99/14	Peoples Awareness of Fire	S J Rusbridge
99/15	Smoke Explosions	B J Sutherland
99/16	Reliability of Structural Fire Design	JKS Wong
99/17	Heat Release from New Zealand Upholstered Furniture	T Enright
00/1	Fire Spread on Exterior Walls	FNP Bong
00/2	Fire Resistance of Lightweight Framed Construction	PCR Collier
00/3	Fire Fighting Water: A Review of Fire Fighting Water Requirements (A New Zealand Perspective)	S Davis
00/4	The Combustion Behaviour of Upholstered Furniture Materials in New Zealand	H Denize
00/5	Full-Scale Compartment Fire Experiments on Upholstered Furniture	N Girgis
00/6	Fire Rated Seismic Joints	M James
00/7	Fire Design of Steel Members	K R Lewis
00/8	Stability of Precast Concrete Tilt Panels in Fire	L Lim
00/9	Heat Transfer Program for the Design of Structures Exposed to Fire	J Mason
00/10	An Analysis of Pre-Flashover Fire Experiments with Field Modelling Comparisons	C Nielsen
00/11	Fire Engineering Design Problems at Building Consent Stage	P Teo
00/12	A Comparison of Data Reduction Techniques for Zone Model Validation	S Weaver
00/13	Effect of Surface Area and Thickness on Fire Loads	H W Yii
00/14	Home Fire Safety Strategies	P Byrne
00/15	Accounting for Sprinkler Effectiveness in Performance Based Design of Steel Buildings in Fire	M Feeney

00/16	**A Guideline for the Fire Design of Shopping Centres**	**J M McMillan**
01/1	**Flamability of Upholstered Furniture Using the Cone Calorimeter**	**A Coles**
01/2	**Radiant Ignition of New Zealand Upholstered Furniture Composites**	**F Chen**
01/3	**Statistical Analysis of Hospitality Industry Fire Experience**	**T Y A Chen**
01/4	**Performance of Gypsum Plasterboard Assemblies Exposed to Real Building Fires**	**B H Jones**
01/5	**Ignition Properties of New Zealand Timber**	**C K Ngu**
01/6	**Effect of Support Conditions on Steel Beams Exposed of Fire**	**J Seputro**
01/7	**Validation of an Evacuation Model Currently Under Development**	**A Teo**
01/8	**2-D Analysis of Composite Steel - Concrete Beams in Fire**	**R Welsh**
01/9	**Contribution of Upholstered Furniture to Residential Fire Fatalities in New Zealand**	**C R Wong**
01/10	**The Fire Safety Design of Apartment Buildings**	**S Wu**

School of Engineering
University of Canterbury
Private Bag 4800, Christchurch, New Zealand

Phone 643 364-2250
Fax 643 364-2758